This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

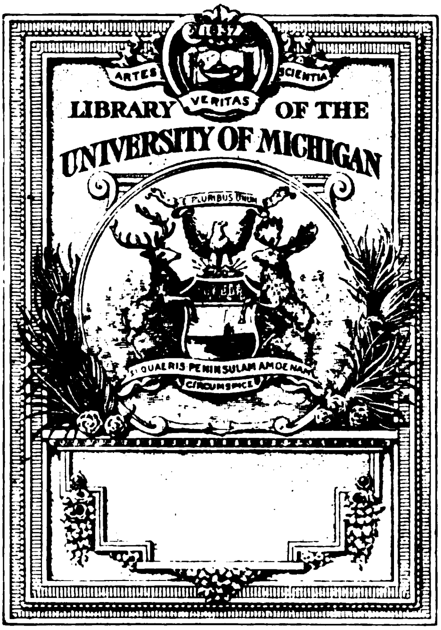
+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

B 436644



1837
ARTES
VERITAS
SCIENTIA
LIBRARY OF THE
UNIVERSITY OF MICHIGAN
E PLURIBUS UNUM
SI QUAERIS PENINSULAM AMOENAM
CIRCUMSPICE

SF
11
.A3

BULLETIN No. 8.

U. S. DEPARTMENT OF AGRICULTURE.
BUREAU OF ANIMAL INDUSTRY.

INVESTIGATIONS

CONCERNING

INFECTIOUS DISEASES AMONG POULTRY.

BY

THEOBALD SMITH, Ph. B., M. D., and VERANUS A. MOORE, B. S., M. D.,

UNDER THE DIRECTION OF

Dr. D. E. SALMON,
CHIEF OF THE BUREAU OF ANIMAL INDUSTRY.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1895.

631
1158

BULLETIN No. 8.

U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF ANIMAL INDUSTRY.

INVESTIGATIONS

CONCERNING

INFECTIOUS DISEASES AMONG POULTRY.

BY

THEOBALD SMITH, Ph. B., M. D., and VERANUS A. MOORE, B. S., M. D.,

UNDER THE DIRECTION OF

Dr. D. E. SALMON,
CHIEF OF THE BUREAU OF ANIMAL INDUSTRY.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1895.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Animal Industry,
Washington, D. C., June 29, 1895.

Sir: I have the honor to transmit herewith a report of Drs. Theobald Smith and Veranus A. Moore concerning investigations of certain infectious diseases of poultry. This subject is one of great interest and importance to most people of this country who are engaged in agricultural occupations, and particularly to all who make a specialty of some branch of the poultry industry. There are a vast number of our citizens engaged in the production of poultry and eggs, either for their own use or for sale, and most of these at one time or another suffer losses and have their operations interfered with by outbreaks of infectious diseases. Such diseases are as destructive with birds as with other kinds of animals, and until recently they have received little systematic study from competent scientific men.

The investigations, of which an account is presented in this bulletin, open up a new field for scientific inquiry. While the work which has been accomplished is but the first step, it reveals how little has been known and how much is to be learned in regard to the diseases of birds. The greater part of the losses from infectious diseases in the poultry yard may probably be prevented by the intelligent application of proper sanitary measures. Until the nature of these diseases is clearly understood, however, it is impossible to intelligently formulate preventive measures or to prescribe successful methods of treatment.

The financial investment in domesticated birds is of such magnitude, and the products are marketed in such vast quantities, and are so essential to the well being of every citizen that the problems affecting this industry are deserving of the most careful study and investigation. The researches herein reported have been made in the hope and expectation that they would be continued until practical means of preventing the common infectious diseases are placed within the reach of all engaged in the poultry industry.

Very respectfully,

D. E. Salmon,
Chief of Bureau of Animal Industry.

Hon. J. Sterling Morton,
Secretary of Agriculture.

LETTER OF SUBMITTAL.

U. S. **Department of Agriculture,**
Bureau of Animal Industry,
Washington, D. C., April 2, 1895.

Sir: I have the honor to submit herewith some preliminary studies of infectious diseases among poultry, including fowls, turkeys, and pigeons. Though these studies have not yet reached that state which permits us to recommend any well-defined preventive or curative measures, it is to be hoped that they will give those immediately interested a better insight into the nature of some of these diseases, besides furnishing investigators throughout our country a more secure basis for further experimentation.

Very respectfully,

Theobald Smith,
Chief of Division of Pathology.

Dr. D. E. Salmon,
Chief of Bureau of Animal Industry.

TABLE OF CONTENTS.

Page.

AN INFECTIOUS DISEASE AMONG TURKEYS CAUSED BY PROTOZOA (infectious entero-hepatitis). By THEOBALD SMITH 7
- Special characters of the disease 8
- The micro-organism (*Amœba meleagridis* n. sp., 1895) 15
- The relation of bacteria to the disease 21
- The relation of this disease to certain other diseases of poultry 22
- General conclusions 24
- Appendix 27

A PRELIMINARY INVESTIGATION OF DIPHTHERIA IN FOWLS. By VERANUS A. MOORE 39
- Outbreaks 42
- Bacteria associated with the lesions 53
- Description of the nonmotile bacillus 56
- Prevention and treatment 58
- The relation of diphtheria in fowls to public health 60
- Conclusions 61

A STUDY OF A BACILLUS OBTAINED FROM THREE OUTBREAKS OF FOWL CHOLERA. By VERANUS A. MOORE 63
- History of the outbreaks 64
- Description of the bacillus 65
- The nature of the inoculation disease 67

ON A PATHOGENIC BACILLUS OF THE HOG-CHOLERA GROUP ASSOCIATED WITH A FATAL DISEASE IN PIGEONS. By VERANUS A. MOORE 71
- History of the disease 71
- Description of the bacillus 73

LIST OF ILLUSTRATIONS.

Facing page.

PLATE I. Photographic reproduction of the cæcum and the spleen from a turkey affected with the protozoan disease 78

II. Drawings of normal and diseased cæca and of the spots on the liver. 80

III. Recent and advanced stages of the liver disease 82

IV. Microscopic appearance of the diseased cæcum and liver with the microparasites shown 84

V. Drawings showing microparasites, giant cells, and flagellates from the blood 86

VI. Drawings showing the diphtheritic lesions in the mouth and on the cornea of a fowl 88

INVESTIGATIONS CONCERNING INFECTIOUS DISEASES AMONG POULTRY.

AN INFECTIOUS DISEASE AMONG TURKEYS CAUSED BY PROTOZOA (INFECTIOUS ENTERO-HEPATITIS).

By THEOBALD SMITH.

[Plates I to V, inclusive.]

In the fall of 1893 the writer received from Mr. Cushman, of the Rhode Island Experiment Station, the organs of an adult turkey in which the liver and the cæca were very extensively destroyed by a peculiar disease. A second case was sent by Mr. Cushman in April of 1894, in which the same disease was recognized. In June of 1894 the writer found the same affection in a very young turkey in western Massachusetts. The changes induced by this affection were so peculiar and yet so uniform in these three cases that a specific infectious disease could not but suggest itself on even superficial examination. A careful study of this material convinced the writer that the cause of this disease was a protozoan parasite not hitherto recognized. It was, therefore, deemed best to investigate the disease more thoroughly, and for this purpose the writer spent three weeks at the Rhode Island Station during the month of August. The turkeys were obtained by voluntary contribution and by purchase, mostly from localities within 5 to 10 miles of Kingston, R. I. Some came from a greater distance. In this work I was greatly assisted by Mr. Cushman, in charge of the poultry work, and by Professor Flagg, director of the station. The chemical apparatus of the station was placed at my disposal by Professor Wheeler.

With the aid of the apparatus brought from Washington and that on hand I was enabled to make a careful examination of about 50 turkeys. Of these, 18 were affected with the specific protozoan disease, and many of the rest were affected with other diseases, briefly referred to under each case.

The short space of time which could be devoted to this subject did not enable the writer to do more than to make a preliminary study of the disease and its cause and to collect material for further study

Now that a firm basis for the investigation of the practical problems has been secured, it is to be hoped that the investigation will be prosecuted during the coming summer, both at the experiment station of the Bureau and elsewhere. The publication of the work thus far done will also enable the various experiment stations to make observations on the communicability of the disease and on means for its eradication.

The external appearances of the turkeys affected with the disease do not seem to be constant, and this is not to be wondered at in view of the varying intensity of the changes found in the internal organs. In Rhode Island the disease is known as "blackhead," owing to certain peculiar discolorations which take place at the height of the disease. While it might be well to retain this as a popular name, we do not believe that all cases of blackhead have the specific disease herein described, nor do all turkeys affected with this disease manifest the appearances of blackhead. More extended study is needed before we may rely upon symptoms as a means of recognizing this disease during life, especially as there are several other affections of turkeys quite distinct from this concerning which there exists as yet very little definite information.

As brought out more fully further on, the disease may be recognized by anyone who has made himself familiar with the salient facts in this article by an examination of the organs of the diseased turkey after death.

Among the symptoms which may be expected to appear sooner or later, diarrhea probably occupies a prominent place. The disease of the cæca is responsible for this. Yet we may have diarrhea with at least one other disease of the cæca, and the presence of tapeworms may also cause this disturbance. Emaciation was not constantly present in the cases dissected by me. As it may accompany other wasting diseases, it can not be depended upon as a sign of this affection.

Leaving this part of the subject we shall turn to those characters of which the investigations have given some definite information.

SPECIAL CHARACTERS OF THE DISEASE.

The disease seems to attack turkeys when quite young. In early June I found a turkey about 3 weeks old (No. 3) in which the disease had already made considerable progress. It seems, moreover, as if the disease were contracted only by the young, because in the examination of turkeys of different ages the oldest showed lesions of the longest standing; that is, such as had undergone the most extensive transformation. In general it may be said that the age of the turkey corresponded with the age of the disease process. The most serious and extensive destruction of tissue was noticed in the turkeys in fall. In midsummer the disease was making most progress; that is, it was freshest and the microparasites present in great numbers. It is probable that the delicate tissues of the young are best adapted for the temporary habitat and rapid multiplication of this parasite. In this regard it simply follows the rule observed by large numbers of parasites, whose most destructive action is visited upon the young.

The primary seat of the disease are the cæca. From these the liver is invaded. Other organs are not attacked.

The cæca of the turkey in the normal condition are represented by two blind tubes opening into the intestine at a point about 6 inches from the cloaca (Pl. II, fig. 1; Pl. I, fig. 1). They are directed toward the head, the blind end being nearer the gizzard than the opening into the intestine. They lie on either side of the latter, closely bound to it by mesenteries. The tips only are free. The length of the cæca varies according to age. In turkeys 3 months old they are about 8 inches long, while in those nearly a year old they are from 10 to 12 inches long.[1]

The cæca are of nearly the same diameter as the intestine. When only slightly filled they are 4 to 5 mm. (one-sixth inch) in diameter. They may, however, be distended with feces to three times this diameter. The structure of the walls seems to be identical with that of the intestine to which they are attached. The communication between cæca and intestine is somewhat contracted. Near it in each tube there is a convex elevation about one-half of an inch long which is composed of lymphatic tissue. Its surface is usually deeply pigmented. Other lymphoid structures are represented by small elevations only three-sixteenths of an inch in diameter, usually pigmented and scattered sparsely over the mucous membrane. The mucosa itself is folded in longitudinal ridges, which are frequently pigmented.

The cæca usually contain feces in greater or less abundance which are pasty, homogeneous in texture, and greenish in color. Under the microscope they appear to be composed mainly of bacteria. When the feces have a softer consistency numerous flagellates of several distinct forms may be detected in active motion in the feces of the recently killed bird. They appear to increase in number with the increase in the watery constituents of the feces.

Coccidia have also been detected. They were present in No. 3 and in another young turkey of the same flock which died from some unknown cause. In the cæcal contents of No. 17, which was free from disease, similar bodies were found, the largest measuring 32 by 18 μ. They were in form and structure like *Coccidium oviforme* of the rabbit's liver, and perhaps identical with the form seen in the cæca of fowls by Rivolta and Silvestrini and named *C. tenellum* by Railliet and Lucet.[2] It is very improbable that these bodies stand in any genetic relation to the true microparasites of the disease herein described.

The lesions of the cæca are in substance a thickening of the wall, followed in most cases by a destruction of the epithelium and deeper portions of the mucous membrane. This destruction results in the outpouring of a coagulable fluid into the tube (Pl. I, fig. 1; Pl. II, figs. 2, 3, and 4). The thickening of the wall may vary considerably in extent from case to case. It may be uniform over the greater portion of the tube or it may be limited to circumscribed patches. The commonest seat of these lesions is near the blind end of the tube, where it evidently starts and from whence it spreads to other portions. Not infrequently only one cæcum was found diseased, the other normal. This exemption was not due to mildness of the attack, for the other cæcum may, in such cases, be the seat of very extensive changes. Thus of 18 cases only 11 had both cæca involved.

---

[1] The length of the intestine from gizzard to opening into cæca is about 5 feet for turkeys 3 months old and 8 feet for those nearly a year old.

[2] Zoologie Medicale, second edition.

The affection of the cæcum is due primarily to the multiplication of the microorganism to be described below, within the walls of the cæcum. The multiplication may take place chiefly in the mucous membrane, or in the submucous tissue, or it may, though rarely, extend into the muscular coat. The thickening of the wall is the result of several processes—the multiplication of the parasites, the increase of the normal tissue elements, and later on the accumulation of masses of small cells and some giant cells.

In the early stages of the invasion the adenoid tissue between the tubules and in the submucosa becomes greatly increased, owing to the presence of large numbers of microparasites of round or slightly oval outline and from 6 to 10 μ in diameter which stimulate the proliferation of the tissue cells. Numerous mitoses have been seen in this stage. The parasites seem to occupy the meshes of the adenoid tissue either singly or in groups or nests (Pl. IV, figs. 1, 2). In these meshes they are soon enveloped in cells acting as phagocytes, so that the appearance of an intracellular habitat of the parasites is suggested, which is, however, only an appearance and not demonstrated by further study.

The presence of the parasites in this reticulum probably stimulates also the accumulation of lymph cells within the spaces, in virtue of which the mucous membrane is thickened. In this early stage of invasion the epithelium, both of the tubules and of the surface, remains unaffected. The parasites do not invade the epithelium at any time.

As the disease progresses there is a continued increase in the cellular elements of the mucous and submucous coats and a gradual invasion of the muscular coats. Here the bundles of fibers of the circular coat are thrust apart by masses of cells, so that this coat also becomes greatly thickened. The inflammation finally extends to the serous covering, where the blood vessels become greatly dilated and give the cæcum a congested appearance. In cases of ordinary severity the wall of the cæcum, not more than 0.2 to 0.5 mm. (one one hundred and twenty-fifth to one-fiftieth inch) thick normally, according to distention, becomes 2 to 3 mm. (one-twelfth to one-eighth inch) thick.

With the progress of the disease the mucous membrane may be shed and a coagulable fluid poured out into the cæcum. In some cases it appears in isolated masses, which adhere to certain spots of the mucous membrane. In others, this exudate fills the entire tube with a yellowish-white mold (Pl. II, figs. 2, 3). This is built up in concentric layers, and consists of a mixture of blood corpuscles, fibrin, and masses of small round cells, in variable proportion.

In the further progress of the local disease it is not improbable that bacteria are also concerned. The exudate contains immense numbers of them and the denuded mucosa furnishes a favorable place of entry. It is otherwise difficult to explain the continued increase in thickness of the walls of the cæcum after the mucous membrane has been shed. This continued increase in thickness is due to an extensive infiltration of small round cells and the presence of some giant cells. Parasites in this advanced stage are scarce, and usually recognizable only as vacuole-like bodies within the giant cells.

The thickening of the wall is associated in some cases with an extension of the inflammation to the contiguous wall of the intestine, which is thereby firmly attached to the cæcum. Yellowish exudates are sometimes found outside of the diseased cæcum on its serous covering and they bind it inextricably to the other cæcum or to the intestine or attach it to the abdominal wall. In these stages the microparasite is not found. It seems to have done its work by destroying the mucous membrane and to have left the field for miscellaneous bacteria.

In no case were other regions of the digestive tract affected. Though the inflammation set up in the affected cæcum may have extended through the wall to the contiguous intestine and caused the formation of a large amount of neoplastic tissue between the adjoining tubes, the disease did not invade the submucous or mucous membrane and the specific parasites were absent.

Associated with this peculiar disease of the cæca is a more or less serious disease of the liver. In the 18 cases of protozoan disease the liver was very extensively diseased in 16. In two cases only small sclerotic foci were present and in these the lesions of the cæca were evidently at a standstill, or in a condition of active cicatrization. The affection of the liver is in fact a valuable means of recognizing this disease, for wherever it is present we may safely infer that we have the protozoan disease before us. The reverse is, of course, not necessarily true. The disease of the cæca may be so restricted that the secondary liver disease does not appear. Nevertheless, the value of the liver affection is indicated by the fact that in the few cases of cæcal affection in which the disease was of a different character no changes in the liver were manifest (Nos. 25, 41).

The appearance of the liver in the average case of this disease is very striking. The organ itself is enlarged in proportion to the amount of tissue involved. Twice the normal size is probably near the truth, although but one was weighed to accurately determine this point. In this case (No. 52) the liver weighed 10.7 ounces.

Over the surface of the organ are distributed roundish, discolored spots, distinctly demarcated from the surrounding tissue. These spots vary much in numbers, in size, and in appearance. They may be distributed uniformly over the whole surface of the liver or they may be limited in number to a few. They vary from 3 to 15 mm. (one-eighth to two-thirds inch) in diameter. Inasmuch as a detailed description of the different cases examined is given in the appendix, to which the reader is referred, only a general description will be attempted here.

In endeavoring to group these spots according to their general appearance we find several types, which, as will be seen below, correspond to different conditions of the diseased tissue. We have in the early most active disease process, spots like those photographed and figured in Pls. I and II. They are sharply defined circular areas of a lemon yellow or an ocher yellow color. A careful scrutiny shows that the spot is not homogeneous in structure, but made up of a delicate network of yellow, as shown in the plates. This yellow substance represents dead tissue.

In another class of spots we have in place of the yellow meshwork an entirely different appearance. The spot is of a mottled brownish color and contrasts only slightly from the surrounding liver tissue by its darker color. It may contain a central yellow nucleus of dead tissue and a narrow outer border of the same character, or the border may be a dark brownish circular line. The entire spot has an indistinct appearance and is flattened or even slightly depressed below the surface. In some cases the spots assume still another aspect. They are uniformly whitish and shade off somewhat gradually into the surrounding tissue.

If sections be made of the affected organ it will be noticed that these surface spots represent masses of liver tissue in the same condition. The spots are simply the places where these disease foci intersect the surface. Some are found deeply embedded in the liver tissue, and therefore not visible on the surface. The lesion of the liver is thus represented by few or many foci of disease having in general a spherical form and appearing on the surface of the organ as round spots (Pl. III, fig. 1). Occasionally the lesions become more extensive and the death of large portions of liver tissue follows. This is well shown in fig. 2 of Pl. III, where a large volume of liver tissue is transformed into a yellow cheesy substance.

The changes in the liver are most easily explained by assuming that the microparasites are conveyed by the blood directly from the diseased cæca into the liver and there deposited in different places, where they begin to multiply and spread in all directions, thereby forming the spherical foci of disease which appear as circles on the surface of the liver. This theory is borne out by the results of the microscopic examination.

In sections of hardened tissue from the liver in which the disease has but recently begun the affected regions are invaded by large numbers of protozoa, which occupy a kind of reticulum formed probably from the connective tissue stroma. The liver cells have partially or wholly disappeared from these foci. The parasites occupy the meshes of the tissue either singly or in groups. The reticulum is provided with a small number of nuclei, some of which are closely applied to and curved partly around the parasite. The blood vessels are usually much dilated and filled with red corpuscles.

The yellow masses observed with the naked eye in the surface spots in many cases are shown to be patches of an amorphous substance which takes nuclear stains very feebly, the aniline colors not at all. It may be described as a coarse network in the meshes of which small cells, and very rarely parasites, are seen. This substance I assume to be the result of coagulation necrosis of the liver cells by which they have lost their nuclei and have become fused into a formless mass. I at first was inclined to look upon it as fibrinous in character, but the discovery of transitional stages confirms the view that it is made up of dead liver cells. It is probable that the plugging of blood vessels in the liver by parasites carried from the cæcum is the cause of the necrosis, since such plugs or thrombi are not uncommon in sections of the diseased spots.

With the appearance of the microparasites reactive changes begin at once which complicate the process. We have at the outset an active multiplication of the microparasites which take the place of the original liver tissue, and a process of coagulation necrosis going on at the same time. Soon multinucleated (or giant) cells appear which not only take in the microparasites but which are also engaged in removing dead tissue. At least their collection in groups around and within the necrotic areas lead us to assume this. Not infrequently they are grouped around what appears to be a plugged vessel, or else they occupy the lumen of the vessel itself. The presence of round or oval vacuoles within these large cells indicates that parasites have been taken up (Pl. V, fig. 3).

In still older cases the diseased spots are found more or less filled with small round cells which may have passed into the dead regions from the blood vessels. In all cases the latter are more or less enlarged, and they seem to encroach upon the liver tissue, thus filling in part the void produced by the cell death and giving the surface of the liver a brownish mottled appearance wherever the disease spots are.

The processes of advancing disease and necrosis or death of tissue on the one hand, of repair on the other, seem to go on side by side, now one now the other predominating. Of the process of repair case 16 is a very good illustration. In this bird the liver tissue was undergoing sclerosis associated with the true healing process, which is referred to more in detail in the appendix.

Besides the lesions directly due to the microparasites in the cæca and in the liver, there were no changes observed to indicate that the parasite was multiplying in other parts of the body. Even where the disease was extending locally from cæcum to adjoining intestine, the process was not due to any advance or invasion of the parasites themselves.

Regularly recurring changes in other organs due indirectly to the destruction of liver tissue, and to the loss of the cæca as important aids in the process of absorption were not manifest.

The blood of many of the cases was examined before the bird was killed in order to detect any existing blood infection. No disease of the blood was observed, however, excepting in No. 16, in which a pronounced leucocytosis was present. In this case the disease was disappearing and the liver undergoing sclerosis, as stated above. In a small number of cases, some diseased, some healthy (Nos. 5, 6, 12, 15, and 33) flagellates were detected in variable numbers. They were evidently not related in any way to the protozoan disease. These bodies (Pl. V, figs. 6 and 7) are spindle-shaped and made up of an oval, feebly granular, central body (nucleus) around which the cell body forms two lateral wings and two tapering extremities finely granular in structure. Motion was not detected at the temperature of the surrounding air. Higher temperatures were not applied. The nucleus of this flagellate is about 25 μ long and 6 μ broad. The entire organism is 65 to 70 μ long. When the blood is dried in thin films upon cover-glasses and stained, these bodies appear in many instances much broader than in the fresh condition. This would suggest that the organism may be a flattish body rolled up so as to bring the two lateral margins near together.

The results of the examination of turkeys made thus far indicate that the disease may follow several courses:

(1) After a certain period of disease regenerative processes begin which tend toward a permanent recovery.

(2) The disease may proceed so rapidly from the very start that the affected turkeys die early in life.

(3) The disease may come to a standstill, but the amount of dead tissue in the cæca and liver may be so great as to favor the entrance of bacteria which are responsible directly for the death of the bird late in the summer or fall.

The direct action of the microparasites upon the body seems to lead to a mechanical destruction of tissue. In this respect they differ from most bacteria, which may combine a locally destructive process with a general poisoning of the body. The extensive destruction of liver tissue combined with the loss of the use of one or both cæca in the digestive process must of necessity lead eventually to weakness and emaciation. The feebler resistance of the affected animals was brought to our notice last summer by their speedy death after a long ride or a few days of confinement.

As regards the spontaneous cure of infected birds we may regard it as probable that only those in which the disease comes to a standstill before it has made much headway are likely to recover. In those in which much destruction of tissue has taken place complete recovery is impossible. The dead masses embedded in the cæca or the liver, or both, form a nidus for bacteria of certain kinds. These penetrate into the pleuroperitoneal cavity and there set up inflammation and finally lead to a general septic infection of the body. The immediate effect of the disease may thus be very slight at the outset and the symptoms develop slowly. The great increase in the size of the liver indicates a certain amount of compensation for those portions which have been destroyed.

The effect of the disease on the flesh of turkeys killed in the early stages is not recognizable. In a few cases which died from a severe form of the disease the flesh had a mahogany color, probably due to retained biliary substances.

THE MICROORGANISM.

(*Amœba meleagridis n. sp. 1895.*)

In the 18 cases of this disease which came under observation either the liver or the cæca, or both organs, were examined microscopically in 14. In these organs certain microorganisms were detected in all but one case and associated directly with the peculiar disease process already described. In those cases in which the disease was recent, or at its height, the parasites were very numerous in the affected tissues, while in those in which the disease process was far advanced, and associated with degenerative or regenerative changes, the parasites were found with difficulty. These facts are summarized in the following table:

Table showing the post-mortem results (microoganism) in 18 affected turkeys.

No. of turkey.	Approximate age.	Source.	Manner of death.	Extent of cæcal disease.	Extent of liver disease.	Microparasites in—		Stage of disease.
						Cæcum.	Liver.	
1	6 months	Rhode Island	Died	Extensive, both cæca	Extensive	Scarce	None seen	Old.
2	10 months	do	do	Extensive, one cæcum	do	do	Scarce	Do.
3	3 to 4 weeks	Massachusetts	do	Extensive, both cæca	Moderate	Abundant	Abundant	Recent.
4	3 months	Rhode Island	do	do	Extensive	Not examined	Not examined	
5	2 months	Farm A, R. I.	Killed	do	Moderate	do	Numerous (in fresh tissue).	More advanced.
6	2 to 3 months	Farm B	Died	Extensive, one cæcum	Slight	do	Moderate	Do.
8	do	Farm C	Died (confined)	Moderate, both cæca	Very slight	None seen	Not examined	Probably healing.
9	3 months	Farm D	Died	do	Extensive	Scarce	Scarce	Advanced.
14	do	Farm G	do	Extensive, both cæca	do	do	Moderate	Do.
16	do	do	Killed	do	Sclerosis	Moderate	Scarce	Healing.
19	3 to 4 months	Farm J	Injured in catching.	Moderate, one cæcum	Extensive	Not examined	do	Advanced.
23	do	Farm L	Died	Extensive, one cæcum	Very slight	Scarce	Not examined	Do.
26	3 months	Farm G	Killed	do	Extensive	Abundant	Abundant	Active.
34	2 to 3 months	Farm K	Died	Moderate, one cæcum	do	Very abundant	Not examined	Do.
35	do	do	do	Moderate, both cæca	do	Not examined	do	Do.
36	3 months	Farm N	do	do	do	Scarce	do	Advanced.
51	5 to 6 months	Farm B	do[1]	Extensive, one cæcum	Moderate	Not examined	do	Old.
52	do	do	do[2]	Slight, one cæcum	Extensive	do	do	Do.

---

[1] Death probably from septic infection.

[2] Death probably from injury during journey.

In the examination of the parasite within the tissues minute particles of the latter were crushed in iodized amniotic fluid or in normal salt solution. Sections were also made. Unfortunately, a freezing microtome was not at hand, nor any warm stage for determining the effect of higher temperatures on these bodies.

The most frequent appearance presented by the parasites under these circumstances was that of round homogeneous bodies with a sharply defined, single-contoured outline (Pl. V, fig. 1). Their appearance suggests that of the myelin bodies found in the cells of the pulmonary alveoli, not refrangent enough to represent oil globules, but too homogeneous to represent the ordinary protoplasm. Within these bodies and situated somewhat eccentrically is a group of very minute granules, probably representing a nuclear structure. These forms were encountered in those cases in which the parasites were found most abundant in sections of hardened material (Nos. 5, 24, 26); also in one case in which repair was evidently going on (No. 16). They vary somewhat in size. In Nos. 5 and 16 those that were measured were 8 to 10 μ in diameter. In No. 26 they were 12 to 14 μ in diameter. In No. 34 some of the bodies were oval, having diameters of 12 and 15 μ, respectively. They are thus distinctly larger than the parasites within the tissues, which have undergone the hardening process. The latter are from 6 to 10 μ in diameter. This difference may be due to shrinkage, on the one hand, and on the other to a slight flattening of the bodies by pressure in the fresh preparations. These peculiar homogeneous bodies were found, as a rule, free in the crushed preparations, although occasionally giant cells were detected which contained a number of them. The cell nuclei of the giant cell were not visible in the fresh condition. Numerous coarse granules were embedded in its protoplasm, less frequently fat globules.

Besides the homogeneous bodies, organisms of nearly the same size but with uniformly granular protoplasm were also found, chiefly within giant cells. These were not infrequently broken and rims or fragments of protoplasm were left attached to the parasite (Pl. V, fig. 2).

For the study of hardened material the tissues were removed in most cases immediately after the bird had been killed, and placed in one or more of the following fixing and hardening agents: 95 per cent alcohol, saturated solution of corrosive sublimate, Foa's solution (equal volumes of the preceding solution and a 5 per cent solution of bichromate of potash), Flemming's solution (undiluted). The tissues were fixed in the three last mentioned during one day, then washed in running water during another day and treated with ascending strengths of alcohol, according to the usually prescribed rules. The tissues were then passed through absolute alcohol and chloroform, infiltrated in paraffin, and the sections cut dry. Various staining reagents were employed, including Delafield's hematoxylin and eosin, alum carmine, Biondi's triple stain, saffranin, Gram and Gram-Weigert's stain. Of the fixing and hardening agents I am unable to consider any one as superior to the other in bringing out the parasites in the tissues when subsequently stained. By this I do not mean to infer that there was no preference when their action upon the tissues is considered, for here they manifested their respective peculiarities already well known. But the fact remains that now the one, now the other, tissue demonstrated the parasites best. In general, hardening in corrosive sublimate and alcohol and staining in Delafield's hematoxylin and in eosin proved the most successful. The bodies were, however, brought out with other dyes, such as methylene-blue, with variable distinctness.

The microparasites as found in sections of hardened tissue are spherical or slightly oval bodies from 6 to 10 μ in diameter. In sections stained with hematoxylin and eosin they have a homogeneous bluish-red tint, feebler than that of the tissue nuclei of the host. They are, however, distinctly seen, and the advantage of a more intense stain is questionable. In most of these bodies a minute, distinctly blue ring is seen situated centrally or somewhat eccentrically and representing the nucleus. This is about 2 μ in diameter. With high powers a very minute (nucleolar?) point may be seen in some parasites within the nucleus. Other differentiations of structure were not noticed.

The presence within the connective tissue spaces of parasites in groups of two or more individuals, as well as of single individuals, makes it highly probable that at least in the early stages of the disease there is active multiplication of these bodies. This appears to go on as a simple process of division, if we are to judge from the grouping within the tissues. The variation in the number of individuals composing such groups, as well as the absence of any common membrane inclosing each group, indicate at least that the multiplication is not an endogenous segmentation such as belongs to the sporozoa.

This brings us to a consideration of the nature of these protozoa. Their simple structure would lead us to class them with the amœbæ, of which one form is now known to produce a similar disease in the human subject (amœbic dysentery). Amœbæ are also not uncommon inhabitants of the large intestine of man and certain animals. The peculiar homogeneous structure and rigid outline of the organisms before us as they appear when examined in tissues directly from recently killed animals may represent a kind of encystment in the presence of the adverse forces of the animal tissues. In the sharply defined vacuoles within the giant cells this rigid form seems to have left a permanent impression (Pl. V, fig. 3).

The relation which the parasite bears to the microparasites found in external tumors or warts (*Molluscum contagiosum*) of fowls, or to those flagellates which are associated with diphtheria in fowls, or finally to the diphtheria referred to in text-books as due to gregarinosis may be a very distant one. Yet, in the present state of our information concerning these parasites, it is worth while to be on our guard before making positive assertions, and leave it to future work to decide if any relationship exists.[1]

We are naturally led, in a consideration of this microorganism, to inquire what relation it bears to the tissue cells of the host. Is it an intracellular parasite during any portion of its parasitic existence? The evidence brought forward here would lead me to state that it lives in the interstices and lymph spaces of the tissue, but not within cells. This seems certainly true of the cæcum. In the liver the liver cells seem to become necrotic or else disappear so rapidly that it is impossible to determine just where the parasites begin to multiply. They do not live within the blood vessels, as they are not found within them excepting perhaps in a thrombosed vessel. They must, therefore, occupy the place of the liver cells. It is probable that they begin to multiply in the connective tissue adjoining the blood vessel, and simply crowd out the liver cells, leaving the connective tissue stroma of the lobules in whose meshes they are found.

Their presence within giant cells is seen in almost every infected organ subject to examination. In teased preparations of the fresh tissues they are frequently found with remnants of the inclosing cells still attached. This intracellular condition is, however, a purely passive one so far as the parasite is concerned.

The fate of the microparasite within the tissues of the host seems to tend toward destruction. Both the death of the tissue itself and the repair seem to lead to the disappearance of the parasites. In most cases there may be seen in the same section a partial dissolution of some of the bodies, while others are still in good preservation. Evidently their life within the tissues is not very long. The attack upon them by large giant cells in the later stages of the disease has already been mentioned.

A discharge of the microparasites which escape destruction probably takes place from the walls of the cæcum, when these break down, into the contents, in which they are carried outward. A similar discharge may take place from the liver through the bile ducts into the intestine. Another way of dissemination would be in the death of the diseased turkey and the dissolution of its body whereby the organisms are set free. Speculations in this direction are, however, of little value until experiment shall have determined whether turkeys are infected directly from sick turkeys, from healthy, immune or recovered turkeys, in whose cæca the parasite may perhaps vegetate indefinitely, or from some external source.

The close analogy existing between this disease and that of amœbic dysentery in the human being deserves at least a brief statement in these pages. The occurrence of amœbæ in intestinal affections of man was noticed as far back as 1875 by Lösch. Since that date it has been the subject of many investigations.[1] Two of the more exhaustive investigations which have appeared are those of Councilman and Lafleur[2] and of Kruse and Pasquale.[3]

---

[1] The presence of numerous flagellates in the cæca of healthy turkeys has already been pointed out on page 9.

The points of analogy between the avian and the human disease are that in both there is an affection of the intestine (large intestine in man, cæca in turkeys) associated with liver disease due to amœbæ.

The intestinal wall in amœbic dysentery is greatly thickened, owing to an œdematous condition. It is also thickened in circumscribed areas and contains cavities filled with gelatinous-looking pus. The amœbæ vary much in size and contain vacuoles. They are found in variable numbers in the bottom of the ulcers and in the discharges. The large numbers of amœbæ found in the intestinal contents led Councilman and Lafleur to infer an active multiplication therein. The presence of the parasites within the submucosa is described by these authors in one case[4] only.

In the turkey we have seen that the parasites are always present in the connective tissue spaces of the mucous and submucous membrane. Their presence in the contents of the cæcum is highly probable from examinations made last summer but not definitely settled, as it is difficult to recognize the parasites in the feces.

The microparasite of the turkey disease differs from the *Amœba dysenteriæ* in being quite uniform in its appearance, varying but slightly in size (from 6 to 10 μ in diameter) and in being free from vacuoles. Movements characterized as amœboid have not yet been demonstrated.

The liver affection in man appears usually as an abscess. In turkeys it appears as a variable number of foci in which the microparasites may be present in great abundance. The difference in the nature of the lesions must be largely attributed to the different reaction of the tissues of birds toward injuries. This brief statement must suffice to point out the analogy between the human and the avian disease, and the tracing of any further relationships must be left to those specially interested in this subject.

Before concluding the discussion of the microparasite of this disease I desire to refer briefly to peculiar organisms found in the lumen of the tubules of the cæca. Fig. 5 of Pl. V depicts these bodies very well. The figure represents a cross section of one of the tubules from the diseased cæcum of No. 26. It will be noticed that the tube is packed with minute organisms of a roundish or oval outline provided with a more deeply stained body, probably a nucleus. The organisms, after being fixed in corrosive sublimate and hardened in alcohol, measure from 4 to 5 μ in diameter. The nuclear body, though it appears round or oval in the figure, is actually more complex in form. Careful focusing with a high power (× 1,000) shows a spindle-shaped or oval body which may be bent like the arc of a circle. Its shortest diameter is about 1 μ. At first I was inclined to look upon these bodies as blood corpuscles which had escaped into the tubules during the disease process from the cavity of the cæcum. This view is made very improbable by a number of facts. The red corpuscles in the capillaries of the same section are quite different from these bodies, both as regards the color of the hemoglobin, and the form, size, and structural appearance of the nucleus. These problematical objects assume a bluish-pink color when stained in hematoxylin, and the nucleus stains quite deeply and solidly. Again, it would be difficult to understand why all the tubules should become packed with these bodies if they were blood corpuscles. Another supposition, that they might be some stage of the microparasite of this disease does not harmonize with the fact that they are found within the tubules of the healthy cæcum (No. 47). They may be absent in cases where the disease is most active (No. 3). On the other hand, they were very abundant in No. 26, and less so in No. 16.

---

[1] For a good résumé, with citations of the literature, the interested reader is referred to Schuberg: Centralblatt für Bakteriologie, XIII (1893), Nos. 18 to 22 inclusive.

[2] W. T. Councilman and H. A. Lafleur. Amœbic Dysentery. The Johns Hopkins Hospital Reports, II (1890-91), pp. 395-548.

[3] W. Kruse u. A. Pasquale, Untersuchungen über Dysenterie und Leberabscess, Zeitschrift f. Hygiene, XVI (1894), pp. 1-149.

[4] Loc. cit., p. 490.

The most satisfactory assumption is that these organisms represent one of the unicellular animals, probably a flagellate. It is interesting to note that flagellates were found in large numbers in the fresh contents of the cæcum of No. 47, in which these bodies were found within the tubules in sections of hardened tissue.

There is probably no genetic relation between this hypothetical organism and the true parasite of the disease under consideration. The latter is larger, its nucleus is smaller and simpler in form, and its behavior toward staining reagents is different both as regards the cell body and the nucleus. It would seem, on the whole, that we have here a microorganism which inhabits the cæcum and by preference the depths of the tubules. Its effect upon the health of the turkey can, of course, be only conjectured at present.

THE RELATION OF BACTERIA TO THE DISEASE.

From what has been stated concerning the presence of the protozoan parasite in the diseased tissues, there can be little doubt that they must be regarded as the cause of the disease. In the course of the investigations the possible bearing of bacteria upon the disease was not entirely overlooked and cultures mainly upon agar were made from the blood and the liver of a considerable percentage of the infected turkeys. Usually, bits of liver tissue were transferred to the culture tubes. Of the heart's blood, one or two loops were inoculated. The results obtained varied from case to case. As a general rule, tubes inoculated from birds that had just been killed remained free from growth, whereas the cultures of those which had died during the night and were examined next morning were quite regularly fertile. The bacteria isolated from these cultures were examined by Dr. C. F. Dawson, assistant in the laboratory, and most of them found to be *B. coli communis*. Several of these were afterward reexamined by me and his results confirmed.

The absence of any uniformity in the bacteriological results as well as the appearance of *B. coli* in the organs of dead turkeys indicates that pathogenic bacteria were not associated with the protozoa in the cases examined. It furthermore warns us to be careful not to attribute to such bacteria as may be found the power of producing disease, as has been lately done by Lignières,[1] who found *B. coli* in the organs of a small number of dead fowls and claimed, without positive proof, that they were the cause of a septicæmia.

THE RELATION OF THIS DISEASE TO CERTAIN OTHER DISEASES OF POULTRY.

(1) *To other diseases of the cæca in turkeys.*—In the investigations made in Rhode Island three cases came under my observation which make it certain that not all diseases affecting the cæca of turkeys are due to the protozoa described.

Of one case (No. 7) only the intestines were obtained. One of the attached cæca was greatly distended by an exudate, similar to that found in some cases of the protozoan disease. At about 1 inch from the blind end the cæcum abruptly swelled out to a diameter of 1¼ inch. The enlarged portion was about 2 inches long and very firm to the touch. The whole mass was placed unopened in alcohol. When it was subsequently opened the enlargement was found due to a firm exudate with a narrow canal passing through the center. The exudate readily peeled away from the wall, which was but slightly thickened.

The second case (No. 25) was similar to this. Only one of the cæca was affected. The notes on this case are as follows:

One cæcum slightly distended by a rather firm cylindrical mass of feces encased in a whitish leathery exudate made up of concentric layers. The whole is not adherent to the mucosa. This membrane is dull, slightly congested. The wall is very slightly thickened. The liver is free from disease.

In the intestines are numerous tapeworms. Two cultures were made by placing bits of liver tissue in tubes of inclined agar. In both, colonies appeared. These were subsequently found to be closely related to *B. coli communis*.

In the third case (No. 41) both cæca were diseased, the liver normal.

One cæcum was very much distended over a distance 3 inches long, attaining a diameter of three-fourths of an inch. From the serous aspect the wall appeared very hyperæmic. When the tube was slit open the distension was found due to a cylindrical mass of exudate, very firm, yellowish white. The exudate appears deposited in concentric layers. The lumen of the tube within this exudate was almost occluded. Odor strongly fecal. The exudate easily peeled away from the wall in a single mass. The wall was smooth and hyperæmic and but slightly thickened.

---

[1] Septicæmie à coli bacille chez la poule. Compt. rend. Soc. Biol. 1894, p. 135.

This exudate was hardened in alcohol and transverse sections cut from it. These show that it is composed almost exclusively of a meshwork of amorphous material, probably fibrin. Cell groups were found in but one locality of the exudate.

The other cæcum is only slightly distended. It contains a mass of exudate about 1 inch long and one-third of an inch in diameter lying loose in the cavity. The mucosa is roughened and covered with a thin slough or exudate.

Sections of the wall of this cæcum show the mucous membrane replaced by a layer of young connective tissue cells in which tubules are absent excepting in circumscribed regions in which the remnants of the tubules are still recognizable in the amorphous mass adhering to the submucosa. The muscular coats are not penetrated by cell masses, but the vessels of these and the subserous membrane are greatly distended with corpuscles.

The small intestine of this turkey contained numerous small tapeworms.

Two agar cultures were made from heart's blood and one with a particle of liver tissue. In one of the blood cultures a number of similar colonies developed. The bacilli composing one of them had all the cultural characters of *B. coli communis*.

These three cases are of interest as indicating the existence of some other agency, probably bacterial in nature, which affects the cæca of turkeys. It differs from the protozoan disease in the entire absence of any liver affection and in the absence of any marked thickening of the walls of the cæca. The exudate is much more abundant and obstructive than in the protozoan disease. Further investigations are necessary to define more clearly the nature of this affection and its cause. A similar affection of the cæca was found in two turkeys by Von Ratz in Budapest.[1]

He found much thick mucus in the mouth and esophagus. The mucous membrane of the small intestine was studded with hemorrhages and small, removable pseudomembranes as large as lentils. Both cæca of one turkey contained a partly dried, cylindrical mass, and many minute worms 8 to 14 mm. long. In one cæcum of the other turkey the same dry, cylindrical mass, easily removable. The mucous membrane itself was covered with layers of pseudomembrane. The other cæcum was distended with gases and a grayish, semifluid mass. Both contained many roundworms.

The author does not hesitate to attribute the cæcal disease to the roundworms. This conclusion is, however, merely an inference based on the presence of worms and exudate. It is more than probable that the disease is bacterial and secondary to the catarrhal affection of the mouth.

(2) *To disease of the cæca in fowls.*—This is by no means uncommon. Zürn[2] considers it a form of diphtheria which may affect the various parts of the head, the digestive and respiratory organs. He states that the disease of the cæcum may appear as an independent affection in water fowls and turkeys. The disease is accompanied with great depression and weakness. The diarrhea which appears is at first semifluid and mucous, later it becomes fluid and is mixed with blood. The foul-smelling discharges may be followed by constipation, and then the

---

[1] Blinddarmentzündungen bei Truthühnern durch Ascariden verursacht. Deutsche Zeitschrift f. Thiermed., XX (1893), p. 74.

[2] Deutsche Zeitschrift f. Thiermed., X (1883), p. 189.

cæca and the rectum are found after death filled with yellow croupous masses in layers upon the frequently ulcerated mucous membrane. The disease lasts fourteen to twenty days or even two to three months. Often a relapse follows an apparent cure. He states that it frequently happens that the croupous or diphtheritic affection of the throat, nose, and eyes appears healed, when suddenly the intestinal disease breaks out and usually ends fatally.

The writer has seen two instances of disease of the cæcum in fowls. In one case one cæcum had its walls very much thickened. The same was true of the second case. In this the thickening was due to a reparative inflammation following the loss of a greater part of the mucous membrane. In sections of hardened tissue protozoa were not recognized. It is probable that in this fowl the disease was secondary to a dipththeritic affection of the head.

Siedamgrotzki[1] describes a disease of both cæca in a hen. They were very much enlarged. In one cæcum the wall was thickened by inflammation, but the mucous membrane was intact. In the other the wall was also thickened and adherent to neighboring organs. The mucosa was covered with a yellowish-brown, thin, pseudomembrane.

Disease of the cæca in poultry seems to be a widely distributed affection, both primary and secondary to other diseases, and evidently due to more than one agency. It is to be hoped that more will be known concerning these affections in the near future, and that the demonstration of one specific cause in the form of protozoa will pave the way for the determination of the others.

GENERAL CONCLUSIONS.

In the preceding pages we have shown that there prevails a disease of turkeys which attacks the young by preference, which runs no regular course, but varies from bird to bird in severity, duration, and termination. It begins in the cæca and thence invades the liver through the blood. Though restricted to these two organs, its action is severe enough to prove fatal to many affected turkeys. We have seen that the disease process is always associated with a protozoan parasite of very minute size, whose destructive action is due in the main to its powers of rapid multiplication within the tissues. It is probably discharged with the droppings of the diseased birds. These are the main facts learned by the brief investigations of last summer. While we may make certain conjectures as to the modes of transmission of the infectious agent based on these investigations, we are at present unable to go further than this until experiments have been carried forward in other directions.

From our present standpoint I think it safe to assume that the microparasite is transmitted from bird to bird without passing through any intermediate host. The microparasite, discharged perhaps in an encysted stage from the sick bird, is taken up with the food and water by others and sets up disease directly.

---

[1] Bericht ü. d. Veterinärwesen im Königreich Sachsen, 1872, p. 84.

If the parasites were taken up with insects, for example, we should expect to find the disease diffused through all flocks. But even the limited experience of last summer leads me to believe that certain flocks only are infected and that by uninterrupted transmission the disease becomes perpetuated and diffused among neighboring flocks. The perpetuation of the parasites I am inclined to think is to be sought for in the older turkeys, which carry them in their body, most likely in the digestive tract during the winter. This view is supported by the fact that turkeys not infrequently recover from the disease. This recovery does not mean, however, the destruction of the parasite within the body, for we have now information concerning the persistence of a variety of parasites—bacteria and protozoa—within the body long after recovery.

The evidence which I have presented in this report seems to show that the turkey is infected early in life and that infection does not take place later on. If this be so, the transmission from the old to the young is easily understood. If the susceptibility to infection remained for any length of time we should expect to find the two cæca infected in every case. But in 7 out of 18 cases only one cæcum was found diseased, the other normal. It is true that other explanations of this condition referable to acquired immunity, might be given, but the one cited seems to be the most acceptable.

If the theory that the disease is transmitted more or less directly from old to young should prove to be true, the remedy for such a state of affairs would appear to lie in two directions:

(1) The disease might be allowed to go on and some remedy found which will check it and lead to a cure; or

(2) The diseased flocks might be entirely destroyed and new birds obtained elsewhere, after a thorough cleansing and disinfection of the territory formerly occupied by the flocks.

The latter alternative, though very heroic and severe at first, seems to me the best in the end, especially as we might search in vain for a remedy which will check the disease in the young. Anticipating the investigations somewhat in this direction, I had hoped to determine the distribution of this disease in the country at large by an appeal for the shipment to this Department of diseased turkeys or organs therefrom. Up to the present no material has been received, so that the study of distribution has made no progress.[1] It is evident that if the disease must be weeded out by a destruction of whole flocks it is highly important to find some locality free from such disease from whence new stock may be obtained. To obtain such information is by no means an easy task, and may be made still more difficult by the infusion of a certain amount of local pride and self-interest. The disease is, however, readily recognized in most cases, so that anyone who has examined the plates of this article and read certain portions of the text may be able to detect it. The peculiar circular spots on the liver, coupled in later stages of the disease with the presence of yellowish cheesy masses or whitish scars in this organ, are very characteristic and probably peculiar to this affection. Disease of the cæca, unless accompanied with the spots on the liver, should not for the present be regarded as belonging to this affection.

---

[1] The cæca of about 30 turkeys from the Washington markets were examined during February of 1895, and found free from disease.

When we come to the subject of treatment some difficulties arise. Though turkeys may appear drooping, unable to keep up with the movements of the flock, and even have diarrhea, the precise nature of the disease is not made clear by these symptoms. Among the 50 turkeys examined many were taken alive as suspicious cases. When killed the protozoan disease was not found. They were suffering from a variety of other affections, the causes of which, mentioned in the order of frequency, were lice, tapeworms, gapeworms, ticks, injury, and a diphtheritic disease of the cæca likely to be mistaken for the genuine protozoan disease. The same treatment applied to such a variety of disorders can hardly be looked upon very hopefully. Still, the subject merits attention. The success which quinine has had in combating malaria leads me to suggest its use to those who are in a position to experiment with this disease. Since the microparasites are embedded in the walls of the cæca and in the liver the remedy to be tried must do more than act locally in the intestines. It must act upon the parasites through the blood, and its effect on the diseased turkey should be carefully watched to note any poisonous action.

The disinfection of the coops and other structures designed to give shelter to turkeys, and other poultry as well, should be carried on as for bacterial diseases until further investigations shall have been made. The following disinfectants are strong enough to kill spores of bacteria, and will probably destroy the various stages of the protozoa:

(*a*) Corrosive sublimate (mercuric chloride), 1 ounce in about 8 gallons of water (one-tenth of 1 per cent). The water should be put into wooden tubs or barrels and the powdered sublimate added to it. The whole must be allowed to stand for twenty-four hours, so as to give the sublimate an opportunity to become entirely dissolved. Since this solution is poisonous, it should be kept covered up and well guarded. It may be applied with a broom or mop, and used freely on all woodwork. Since it loses its virtue in proportion to the amount of dirt present, all manure and other dirt should be first removed before applying the disinfectant. The manure should be covered with lime.

(*b*) Chloride of lime, 5 ounces to a gallon of water (4 per cent). This should be applied in the same way.

(*c*) The following disinfectant is very serviceable. It is not poisonous, but quite corrosive, and care should be taken to protect the eyes and hands from accidental splashing:

	Gallon.
Crude carbolic acid	½
Crude sulphuric acid	½

These two substances should be mixed in tubs or glass vessels. The sulphuric acid is very slowly added to the carbolic acid. During the mixing a large amount of heat is developed. The disinfecting power of the mixture is heightened if the amount of heat is kept down by placing the tub or glass demijohn containing the carbolic acid in cold water while the sulphuric acid is being added. The resulting mixture is added to water in the ratio of 1 to 20. One gallon of mixed acids will thus furnish 20 gallons of a strong disinfecting solution, having a slightly milky appearance.

(*d*) Ordinary slaked lime, though it does not possess the disinfecting power of the substances given above, is nevertheless very useful, and should be used more particularly on infected soil.

APPENDIX.

In the following pages is given the history of the turkeys which have been examined up to the time of the completion of this bulletin. It was thought best to include the brief notes of those turkeys affected with maladies other than those of the infectious disease under consideration, to illustrate the existence of such affections and the necessity for further investigations.

Turkey No. 1.—Portions of the liver, cæca, and lungs received in weak alcohol about the middle of October, 1893, from Mr. Cushman. Age of fowl not known. Lungs dark, congested. The wall of the cæcum is fully 5 mm. thick. In the liver are disseminated firm yellowish masses simulating the cheesy matter in tuberculosis. Tissues not in very good condition for microscopic examination. They were, however, placed in absolute alcohol and subsequently cut in paraffin. Sections of lung tissue show all vessels densely packed with red corpuscles. No other changes.

Sections of the thickened wall of cæcum stained in alum carmine, hematoxylin, and eosin, methyl violet, according to Gram, and in Weigert's fibrin stain. The hematoxylin proved to be the best.

The thickening of the wall is due in the main to cell infiltration of the submucous tissue. The entire mucous membrane is sloughed away, and the submucosa presents a ragged appearance along the exposed border. Throughout the section, and more particularly near the serous aspect, there are many distended capillaries filled with blood corpuscles. The nature of the cellular infiltration not recognizable, owing to imperfect hardening. In certain areas there may be seen, however, a peculiar collection of cells having several nuclei and inclosing large vacuole-like spaces. These spaces were subsequently recognized as having been occupied by protozoa. These phagocytes, with several nuclei shaded off into exceedingly large giant cells, over 80 μ in diameter, often forming large patches by collecting into groups. They are quite uniformly dotted with nuclei, and contain relatively very few parasites.

Sections of liver tissue showed an extensive substitution of the parenchyma by numerous and greatly dilated blood vessels within newly formed connective tissue.

In such areas only a few islands of liver cells are recognizable. Parasites not seen. Giant cells rare.

Turkey No. 2.—Liver and a portion of the intestine, with cæca attached, sent by Mr. Cushman from Rhode Island on April 2, 1894, and received April 5. Turkey probably a large one.

Post-mortem changes well under way when organs were received. It was, however, not difficult to recognize the disease. Only one cæcum affected. About one-half of the tube, beginning with the blind end, is almost completely occluded with a firm, pale-yellowish exudate having the appearance of concentric layers when cut across, like the rings of a tree. The occlusion is complete at the blind end. The tube, usually only 0.5 to 1 cm. (two-fifths inch) across, is distended to 2 cm. (four-fifths inch). The exudate is firmly attached to the greatly thickened walls. Sections of hardened tissue show that the entire wall of the cæcum, or what is left of it, is densely infiltrated with round cells. The lesions characteristic of the earlier stage of parasitic invasion no longer recognizable.

The liver is beset with a considerable number of circular, slightly depressed areas, which have a pale, mottled appearance. They vary in diameter from 5 to 10 mm. (one-fifth to two-fifths inch). When incised the same appearance is presented within the liver tissue, showing that these circular spots simply represent the surface of roundish masses of tissue which have undergone the same change.

In sections of hardened tissue each disease focus is shown to be the scene of a complex process of destruction. The periphery consists of normal liver tissue, the capillaries of which are distended, and gorged with red corpuscles. Within the diseased focus there is disseminated a peculiar meshwork of amorphous, homogeneous matter which stains but feebly in hematoxylin. Its meshes are large enough to hold one or more tissue cells. In some places it resembles more closely mammalian fibrin in its appearance. Liver cells are either entirely absent or present in isolated numbers where this substance appears. Besides this there are areas of considerable cell infiltration and, scattered about without regularity, giant cells. Parasites are present, but in small numbers.

From the liver bits of tissue were placed in three agar and three gelatine tubes. At the same time bits were placed under the skin of a rabbit and a guinea pig. The cultures remained sterile and the animals well.

Turkey No. 3.—Small specimen; probably 3 or 4 weeks old. Died in the morning of June 6, 1894, on a farm in Berkshire County, Mass. Examined several hours after death. Weather quite cold. In this case both cæca and the liver were involved. In the former the walls were considerably thickened, but there was no exudate within the tube and the mucous membrane appeared intact.

In sections of the cæca hardened in alcohol and in corrosive sublimate the wall was found of variable thickness. In some regions it was nearly normal on one side and considerably enlarged on the opposite side. In others the entire cross section was uniformly thickened. The mucosa is still in position and but slightly altered. The cells of the crypts show extensive mucous metamorphosis. The enlargement of the wall is due mainly to an extensive infiltration of the submucosa and of the circular band of muscular fibers with the protozoa. The muscular fibers are pushed apart into strands, or else entirely obliterated. These microparasites are found throughout the entire section in uniform abundance. They are comparatively rare in the reticular tissue of the mucosa between the crypts. In the fresh contents of the cæca were found coccidia with distinctly double-contoured wall. The long axis measured 15 to 20 μ, the short 10 to 13 μ.

The liver of this bird was dotted with about a dozen circular spots, varying in size, some 7 mm. in diameter. These spots consist in the main of minute yellowish lines embedded in the liver tissue and loosely interlacing to form a circular wheel-like area. They thus differ from some other cases to be recorded in less destruction of liver tissue within the circular area, for the yellowish lines represent necrosis of liver tissue.

In sections of liver hardened in corrosive sublimate and alcohol the foci of disease no longer contained any liver tissue. This is replaced by numerous microparasites surrounded and enveloped in a meshwork of reticulated tissue rich in nuclei. Giant cells are present in moderate numbers.

At the time this young turkey died two others were found dead and were examined. Neither was affected with this disease.

Turkey No. 4.—Has been dead for two days. Decomposition well under way. Obtained from a dealer. Extensive spotted disease of the liver and thickening of walls of cæca with exudation into the tube.

Turkey No. 5 (Farm A).—Probably 8 to 9 weeks old. Received alive August 3. Blood from vein of the skin examined. A few fusiform flagellates seen. Nothing abnormal with the corpuscles. Killed. On the neck a small tick. Mouth, trachea, and lungs normal. The digestive tract normal with exception of the duodenum and the cæca described below. The former shows marked pigmentation in points and striæ (villi). In the rectum and cloaca contents pale-yellow, liquid, containing urate spheres in abundance and numerous flagellates.

Both cæca are diseased. They are unusually short, only one-half the length as usually found in turkeys of the same age (Pl. I, fig. 2). Both are distended from one-half to three-fourths of an inch in diameter, and very firm, as if filled up. Vessels on the serous surface injected.

The condition of one of them is shown in Pl. II, fig. 2. The cæcum is slit open longitudinally, and the cut surface exposed to view. The lower two-thirds of the tube is completely occluded by a firm exudate. On the cut surface the wall of the cæcum is shown as an irregular line, indicating marked thickening along the whole length of the tube. The exudate is pale yellowish-white in color, excepting below, where it is largely made up of a blood clot. The main mass contains centrally an irregular cavity. Above, the tube is filled with small round stones, probably discharged from the gizzard. The other cæcum has its wall very much thickened, as shown in Pl. II, fig. 3. The exudate is also present, but not attached to the walls in the alcoholic preparation.

The liver, which is enlarged slightly, is spotted on all surfaces with isolated and confluent areas of a circular outline and pale yellow in color. They rarely exceed 4 mm. (one-sixth inch) in diameter. On closer scrutiny the yellowish color is seen to appear as a network. These disks correspond to masses of diseased tissue within the substance of the liver.

In crushed, fresh tissue are found isolated and agglomerated bodies of a round form, with a homogeneous colorless disk and a single-contoured outline (Pl. V, fig. 1). Near the center of these bodies is seen a small mass of very fine refrangent granules. They are 8 to 10 μ in diameter. One per cent acetic acid will not affect their appearance.

Three cultures on inclined agar were made with a large and two small bits of liver tissue and a large bit of spleen tissue (about the size of a pea). Furthermore, tubes were inoculated with a loop of blood and with a loop driven into the liver tissue. The six tubes remained free from growth.

Turkey No. 6 (Farm B).—Selected because of slightly reduced condition. Cooped for two days. Found dead August 5.

In abdomen some blood-stained serum. Considerable hyperæmia of serous covering of gizzard and of mesenteries. The blind ends of cæca knotted inextricably together, enveloped in a mass of yellow exudate, and attached by means of it to neighboring coils of the intestine and to the abdominal wall. The latter is infiltrated and discolored at this point. After some dissection it was found that only one cæcum was primarily diseased. This was filled with an exudate at the blind end for a distance of three-fourths of an inch.

The liver is somewhat enlarged, and on its surface are a small number of pale yellowish areas fully one-half of an inch in diameter. They correspond to masses of similarly affected tissue in the liver.

Sections of liver tissue hardened in alcohol were made through these large pale spots. In these only small fragments of recognizable liver tissue were found interspersed in the diseased focus. Much of this was occupied by a meshwork representing necrosed liver cells fused together. Small necrotic foci were also detected outside of the main focus, embedded in still unchanged tissue. The necrotic meshwork is arranged in spots generally connected, the interspaces being filled up with groups of minute cells and occasional patches of microparasites. Giant cells are common, usually within or on the circumference of the necrotic areas. The microparasites are also inclosed in these cells. The scarcity of these bodies makes it probable that the disease is not longer progressing.

Cultures were made by transferring a loop of heart's blood and a loop which had been forced into the liver through a scorched area to inclined agar.

The blood culture remained sterile. The liver culture contains manifestly several species, only one of which was studied, and found to resemble *B. coli*.

Turkey No. 7.—Received from a dealer the intestines of 16 turkeys for examination. In one of these there was disease limited to one cæcum. (See page 22.)

Turkey No. 8 (Farm C).—Received about August 3 and cooped temporarily. Found dead August 6; alive the day before.

The lesions in this animal are restricted almost entirely to the cæca. In one cæcum the mucosa is beset with about eight peculiar elevations, which have a central yellowish slough and a surrounding infiltrated zone, making the whole crater-like body about three-eighths of an inch in diameter. On the serous surface some of these necroses show as whitish, discolored areas, with injected border.

The other cæcum contains but one ulcer. In the liver several small areas are found which appear necrotic, but whose nature is doubtful.

Transverse sections of a portion of the wall of the cæcum hardened in alcohol were made through one of the ulcers. The mucous membrane had sloughed away over the center of the ulcer, and the submucous tissue and the muscular coat were extensively infiltrated with masses of cells.

Two cultures were made on inclined agar, one with a loop of heart's blood, the other with a bit of liver tissue. The latter remained sterile. From the former two bacilli were isolated, one corresponding to *B. lactis aërogenes*, the other to *B. coli*.

Turkey No. 9 (Farm D).—Brought to laboratory dead. Probably 3 months old. The disease is restricted to the cæca and the liver.

In one cæcum there are three, in the other four, thickenings of the wall, which appear as opaque yellowish spots under the serous covering. Two thickenings are situated near the blind end, the rest near the attached end. From the mucous surface they appear as yellowish spots from one-eighth to three-sixteenths of an inch thick in the center and thinning out from that point.

The liver is beset with large, isolated and confluent roundish patches of a grayish color, mottled with yellowish specks. The same appearance is presented by the cut surface.

In crushed preparations of the liver a few round, uniformly granular bodies, some within what appear to be the remnants of cells, detected.

Sections of liver tissue hardened in alcohol present the usual appearances characteristic of the disease. Sections passing through the circular spots show that a considerable area of such spots consists of the homogeneous meshwork resulting from necrosis and fusion of the liver cells. In some of these, giant cells are situated, singly or in groups, many of them inclosing vacuoles which represent the former seat of microparasites. The regions not occupied by necrotic tissue are largely made up of cells which have a small, round, densely-stained nucleus, enveloped in considerable protoplasm. The nature of these cells is unknown, although it is probable that they correspond to the round cells in the inflammatory processes of mammalia. In the liver tissue beyond the diseased circle isolated foci are present, which are made up mainly of the cells described and some interspersed giant cells. Throughout the diseased area the various cell forms are undergoing degeneration. This manifests itself by a breaking up of the nuclear substance into stained granules of limited number. This phenomenon is especially frequent in the epithelium of the bile ducts, and more rarely the giant cells themselves show this degeneration.

Sections were also made through one of the thickenings in the wall of the cæca. These showed that the thickening was due in the main to a very extensive cell infiltration of the submucosa and of the muscular portion of the wall. Under the serosa the blood vessels are much dilated, and gorged with red corpuscles. The mucosa is not thickened, but is more or less infiltrated at the base. Much of the epithelium is gone, both of the surface and of the tubules.

The microparasites are poorly preserved, but a little scrutiny shows them to be present in certain regions of the mucosa, submucosa, and rarely in the cell masses between the displaced muscular bundles. In the mucosa and submucosa they have invaded large patches, and here they are ranged side by side and are inclosed in a reticular tissue, each parasite by itself. Giant cells are also present in groups, usually consisting of little else than a mass of parasites enveloped in a nucleated network of protoplasm.

Turkey No. 10 (Farm E).—Probably 8 to 9 weeks old. Supposed to be infected because unthrifty. Cooped for a few days. When killed no lesions found. On the skin were some ticks and lice: in the intestines a few tapeworms.

Turkey No. 11.—From the same flock and in the same condition as No. 10. No lesions found when animal was killed. A few ticks on border of meatus of ear. Lice abundant.

Turkey No. 12 (Farm C).—Probably 3 weeks old. Cooped for a week before it was killed. A few flagellates in blood from veins of skin.

Tapeworms in upper small intestines. In soft contents of cæcum immense numbers of flagellates. No disease of cæcum or liver.

Two cultures made with bits of liver added to agar remained sterile.

Turkey No. 13 (Farm F).—Brought alive, because suspected of being diseased. No lesions discovered on dissection. Many small tapeworms in duodenum. In cæcal contents many flagellates.

Turkey No. 14 (Farm G).—About 3 months old. Taken from a flock August 8 because of lack of strength to keep up with the rest when driven. Indications of diarrhea. Placed in a coop, where it died during the night. Examined next morning.

Slight odor of decomposition. A few small warts on skin of neck. The various organs were found normal, with the following exceptions:

Mucosa of duodenum almost blackish, from intense injection and pigmentation of villi.

Both cæca diseased. The left is slightly distended. On serous aspect two yellowish spots, with markedly injected borders, corresponding to thickenings of the walls near the blind end of tube. The mucous surface of one is smooth; to the other an exudate is attached. Besides the thickening at these spots, the free half of this cæcum is somewhat thickened uniformly.

The right cæcum is very much distended over two-thirds of its length. From the serous surface local thickenings are recognizable, which have a yellowish, mottled appearance. The small intestine is firmly attached to one of these. The disease has, however, not invaded the wall of the latter. The border of these spots is intensely hyperæmic. When the cæcum is slit open its width is three to four times that of the undistended tube, and the thickness of the wall varies from one-eighth to one-half of an inch, being not less than one-eighth of an inch over three-fourths of the entire length. When the brownish feces were washed away the increased local thickenings were found covered with firm exudates, usually attached in but one spot.

Sections were examined of that portion of the cæcal wall which was very much thickened, and to which the contiguous small intestine was inseparably attached by the new growth.

The mucosa of the cæcal portion had sloughed away, while that of the embedded small intestine was intact. The neoplastic tissue between cæcum and intestine was fully 1 cm. (two-fifths inch) thick. Inasmuch as the infiltration probably followed the narrow mesentery between cæcum and intestine the original boundary lines of the cæcal wall are no longer recognizable. The muscular coat of the cæcum may be traced for only a short distance into the neoplasm, when it disappears. Micro parasites were not seen distinctly in the diseased tissue.

The liver is very much enlarged, and dotted everywhere with roundish spots of varying appearance. The majority are from 5 to 12 mm. in diameter, round or slightly oval. The center of each is usually occupied by a group of yellowish dots and the circle is bounded by a narrow yellowish ring. The space of the circle is mottled brownish. Among these spots there are also circles of a completely yellowish color On the convex surface of the left lobe there is a very firm, ring-like, yellowish mass, cutting like firm cheese.

In crushed preparations of fresh liver tissue from within the brownish circles many giant cells are seen. They consist of a meshwork of protoplasm of a rather coarsely granular character inclosing spheres which appear homogeneous. The giant cells are up to 30 μ in diameter.

Sections of liver tissue hardened in alcohol and in Foa's solution were also examined. The foci of disease contain necrotic areas in which are numerous giant cells each inclosing a number of microparasites. In some portions there is much cell infiltration in the interlobular tissue around the portal vessels. Among the cells the protozoa are recognizable.

Turkey No. 15 (Farm H).—Obtained alive and killed. About 3 months old. No cæcal or liver disease detected. In duodenum numerous tapeworms. This turkey had probably been injured, for blood extravasation was found under skin of skull.

Turkey No. 16.—About 3 months old. Obtained with No. 14 from the same flock (Farm G). Suffering with diarrhea. After being cooped for two days it was killed August 10. The blood taken from a cutaneous vein of the breast under the wing showed extensive leucocytosis.

The digestive tract is normal, with following exceptions: The mucosa of duodenum is hyperæmic. Tapeworms absent. The rectum, i. e., the bowel from the cæca to cloaca, is also hyperæmic. It contains yellowish masses made up of microscopic spherical crystals (urates).

Both cæca are affected. Contents of a pasty, brownish (nearly normal) character, containing a considerable number of microparasites. Flagellates not seen.

The disease is manifested in both cæca symmetrically by a thickening of the walls of the distal half of each tube. There are a few yellowish spots noticed under the serous covering of the thickened region. These correspond to spots of maximum thickness. The mucous membrane appears intact. The slight pigmentation noticed on the mucous folds is frequently present in cæca otherwise normal.

In tangential sections of the thickened wall in the fresh condition considerable numbers of round microparasites, of a homogeneous appearance, and about 8 to 10 μ in diameter are seen. They are not bound to cells, but appear to be displaceable under the cover glass independently.

In transverse sections of one cæcum hardened in corrosive sublimate and alcohol the increase in thickness of the wall was found to be due to hyperplasia of the submucous tissue and cellular infiltration of the muscular coat. The mucosa itself was intact, the epithelium in place. Interspersed in the hyperplastic submucosa are small nests of giant cells, some containing well-defined microparasites, others only vacuoles, somewhat larger than the parasites. The latter are not diffusely scattered through the tissue, but restricted to these and a few other foci in which they exist free in the meshes of the tissue. The masses of cells between the bundles of muscular fibers resemble those of the submucosa and are free from parasites.

The liver is considerably enlarged. The surface is not smooth but slightly roughened. Scattered over the various surfaces there are in all six or seven yellowish-white homogeneous sclerotic areas which correspond to masses in the liver tissue. In cutting into the liver these foci are found to sheath the hepatic veins. Outside of these sclerotic foci the liver tissue is mottled with gray. In general, the entire liver appears to have passed through a process of sclerosis.

In sections hardened in Foa's solution and in corrosive sublimate the pathological change going on is shown to be essentially a sclerosis following the protozoan infection. Within the disease focus the liver tissue, recognizable as such, is present only in irregular patches of variable extent. The remainder has been replaced by an actively developing connective tissue, still rich in nuclei. Within these areas there is an extensive formation of bile ducts. Parasites were seen in but one spot, where a number of multinucleated cells had ranged themselves around what appeared to be an old thrombus. Here, beyond the encircling giant cells, a group of similar contiguous cells contained a small number of protozoa. The encircling cells themselves also contained a few, and one parasite was recognizable within the thrombus itself. Outside of these spots undergoing repair, the blood vessels are everywhere inclosed in sheaths of new connective tissue very rich in nuclei, encroaching slightly upon the liver tissue itself.

Turkey No. 17 (Farm I).—About 3 months old. Found August 11 in a dying condition in a flock in which a considerable number had died during the past month. The only lesions found were a rather pale condition of the organs. In the small intestine numerous tapeworms. No liver or cæcal disease. In the cæca feces are rather dry, and contain a considerable number of coccidia, varying slightly in size, the largest 32 μ long and 18 μ broad.

Turkey No. 18.—From the same flock as No. 17, and quite sick when found. Killed and placed on ice over night.

In this bird no marked lesions of any kind were noted. The duodenum was hyperæmic and contained more or less mucus. The contents of cæca are fluid and contain numerous flagellates. Cultures on agar from blood and liver remain sterile.

Turkey No. 19 (Farm J).—About 3 to 4 months old. Taken August 11 from a large flock, because suspected of being diseased. Died shortly after being caught. Placed in refrigerator over night. In the pleuroperitoneal cavity a dark clot and much blood-stained fluid; ecchymosis of the left abdominal wall. Source of hemorrhage not detected; probably brought on while being caught.

Organs very pale but not diseased, with exception of liver and the right cæcum. In the latter there are two diseased areas. Near the blind end there is a ring-like thickening of the wall, which has a yellowish color from the serous aspect. The other area is covered with a small mass of exudate, and the thickening of the wall beneath it covers an area about one-half of an inch square. The remainder of the cæcum pigmented in spots and lines.

The liver is very much larger than in the normal condition and covered everywhere with circular spots of varying appearance. There are:

(1) Two completely necrotic, yellow masses of cheesy character, one in the base of each lobe.

(2) Circles of a grayish-yellowish color throughout.

(3) Spots of a mottled brownish appearance. The mottling represents distended vessels.

(4) Spots like the preceding with a necrotic mass in the center. These spots vary in size up to a diameter of three-fourths of an inch.

In crushed preparations of the fresh liver the microparasites are distinctly recognizable. Some appear as free granular bodies, others are inclosed, either singly in a cell, or in groups in large cells. These inclosed bodies are usually free from granules and may show a minute nucleus. They measure from 10 to 13 μ in diameter.

In sections of liver tissue from this case hardened in alcohol the lesions were found to correspond to those in other cases. Sections through a brownish spot showed everywhere marked distension of the vascular channels. These were filled with corpuscles. The parenchyma has largely disappeared and small cells have taken its place. In a few places of the section microparasites are found collected together in large patches. In these, giant cells are occasionally seen.

Turkey No. 20 (Farm I, see Nos. 17 and 18).—Found in field resting on keel and moving along ground with aid of wings. Obtained August 11. Killed and examined August 12.

In trachea six pairs of gapeworms attached. In cæcum and rectum a yellowish fluid (urates) containing many flagellates. No disease of liver or cæca.

Turkey No. 21 (Farm K).—Picked out of a large flock August 11, 1894, because it was much weaker than the rest. No distinct appearances of disease. When killed the organs were found normal, with the exception of the intestines. A mass of exudate lying adjacent to rectum in abdominal cavity binds together rectum, cæca, and neighboring coils. This mass has a cylindrical shape and is about 2 inches long and three-fourths of an inch at greatest diameter. It consists of spongy yellowish exudate, incased in a smooth, leathery capsule. There is no disease of the mucous or submucous tissue in any part of the intestines. The exudate is evidently the result of a tear in the rectum which permitted the escape of feces into the abdomen. These became subsequently permeated with and encased in fibrin while the tear healed up. Odor of this mass strongly fecal. A bit of liver tissue is placed on inclined agar. The latter remains sterile.

Turkey No. 22.—Large female, over 1 year old. Died on Block Island during the night of August 12. Examined on the farm next day. No evidence of liver or cæcal disease. In abdomen a partially smashed eggshell attached lightly to mesenteries.

Turkey No. 23 (Farm L).—About 3 months old. Received, dead, by express August 14. Probably died two days ago. Slight odor of decomposition.

Duodenum very much discolored by pigmentation. Both cæca considerably distended. The left is normal, the right diseased. Fully one-half to two-thirds of its entire length beginning with the blind end is thickened. There are a number of centers where the thickness is increased. At one of these there has been an outpouring of exudate on the serous membrane. The mucous surface of these local thickenings is covered with firm masses of exudate.

The liver contains one sclerotic focus which has a whitish mottled appearance. It is otherwise normal. Three adult pairs of syngames in the trachea.

In sections of the wall of the greatly enlarged cæcum hardened in alcohol the lesions were of an advanced character. The mucosa was almost entirely sloughed away. Only a few remnants of the slough remained, containing some tubules recognizable as such. The submucous tissue was greatly thickened by cell infiltration, and the muscular coat was divided into sections by cell masses which extended to the serous membrane. Under the latter the blood vessels appeared greatly dilated and filled with corpuscles. The microparasites are still present, but in small numbers. They appear in the neoplastic tissue in small patches inclosed by a fringe of round cells. Giant cells are numerous and arranged in groups. Only in one group were microparasites inclosed.

Turkey No. 24.—Taken August 13 from a flock on Block Island, because it was suspected of being diseased. Killed August 14. No lesions were discovered in the organs. One gapeworm found in the trachea and several minute tapeworms in the intestine.

Turkey No. 25.—Taken from the same flock. When killed disease was found in one of the cæca. (See page 22.)

Turkey No. 26.—About 3 months old. Brought August 15 from a large herd (Farm G), and reported as having been feverish for a few days past. The bird is killed and found in well-nourished condition.

Disease limited to one cæcum and to the liver. Fully one-third of the cæcum has its wall thickened. The thickening is most pronounced in spots, to some of which a firm, pale-yellowish exudate is attached. A portion of the diseased tube is placed unopened in hardening fluids for further study.

The liver is enlarged to two or three times its normal size, and uniformly permeated with closely set, but usually discrete, spots, varying in size, a few having a diameter of one-fourth of an inch. They are of a yellowish color, this being due to a fine yellowish network, of which the spot is in fact made up. The details are well shown in the photographic reproduction and in the colored drawing. (Pl. III, figs. 1, 2.)

In teased and crushed preparations of the fresh liver a large number of microparasites are detected. They appear as round, pale, homogeneous bodies, with a sharp line as a border. They are less refrangent than fat globules, and suggest somewhat the color and refrangibility of myelin or Buhl's bodies as they are found in the alveolar epithelium of the lungs of cattle. Their diameter ranges from 12 to 14 μ. Some are surrounded by a narrow rim of protoplasm, containing one or more nuclei, evidently the remains of a cell.

Transverse sections of the diseased cæcum show a mass of exudate occupying a portion of the lumen. In the exudate are embedded strips of perfectly preserved epithelium. The exudate appears amorphous and contains small foci and even large patches of cell masses, probably originating from the inflammatory processes going on.

The thickening of the wall is due in this case chiefly to infiltration of the submucous tissue. In one portion of the sections the muscular portion of the wall is infiltrated to the serous covering. Parasites are, however, not detected in the submucous or muscular cell masses, but are situated exclusively and in very large numbers in the reticular tissue of the mucosa, between the crypts. In this tissue, as well as in the epithelium of the crypts, numerous mitotic figures are recognizable. Giant cells are also present, but in small numbers. The microparasites are lodged, generally singly, in cavities surrounded by one or more nuclei. In some places few or many may be detected, packed away in a space of the reticular tissue.

The parasites are well brought out in the tissue hardened in corrosive sublimate and alcohol, and stained in hematoxylin and eosin. They appear as round or slightly oval bodies, with a faint reddish tinge of the body and a minute blue, ring-like, central or eccentric body, probably the nucleus. They vary from 6 to 8 μ in diameter.

The lumen of the mucous gland is densely packed with bodies roundish in outline and about 4 μ in diameter. The cell body is stained a homogeneous red with eosin, the nucleus bluish with hematoxylin. (See page 20.)

Sections of the liver were made from material hardened in alcohol and in corrosive sublimate and alcohol. They were stained in various ways, the most satisfactory stain being hematoxylin and eosin, by which the microparasite was most clearly brought out. Methylene blue was also satisfactory in bringing the microparasites into relief.

The sections show within some of the areas indicated by the yellowish spots extensive disappearance of the liver cells proper and the presence of a meshwork or network of a homogeneous substance, which suggests a fibrinous exudate, although it has not the fibrillated structure of mammalian fibrin. This meshwork is not uniformly distributed over the affected area, but appears in foci which are connected with one another. The space left is occupied by numerous parasites and giant cells and an occasional group of liver cells. In other foci the liver cells are replaced by a reticulum containing numerous parasites. Usually but one parasite is contained in a mesh and is closely surrounded by one or more nuclei.

Turkey No. 27.—Taken from another Block Island flock as a suspicious case. About 3 months old.

No lesions found in this bird. In the trachea three gapeworms; in the intestine many large tapeworms.

Turkeys Nos. 28 and 29.—Brought from Fishers Island, New York. No lesions in these cases. Many large tapeworms in the intestine.

Turkeys Nos. 30 and 31 (Farm J).—About 3 to 4 weeks old. Brought because they were not doing well. Killed. Intestine found nearly occluded with small and large tapeworms.

Turkey No. 32 (Farm C).—About 3 months old. Killed August 17. No lesions found. In duodenum several tapeworms. In cæcum flagellates.

Turkey No. 33 (Farm B).—About 3 months old. In the blood from a subcutaneous vein some flagellates. No lesions in the internal organs. In duodenum some tapeworms.

Turkey No. 34.—Obtained from Farm K August 18. Died on the way to laboratory.

Bird about 10 weeks old. In body cavity blood-stained fluid. One-half of the left cæcum, beginning at the blind end, has its wall thickened. The serous covering is reddened and shows a few yellow patches which correspond to certain specially thickened regions of the wall whose mucous covering is necrosed.

The liver is large and covered everywhere with rather large, round, dark-brownish patches having a narrow, yellowish boundary line. These correspond to diseased foci within the liver.

In fresh liver tissue, crushed or cut in sections, oval bodies 12 to 15 μ in diameter are present in considerable numbers. They appear homogeneous; contents not differentiated. Similar bodies, inclosed in groups of two or three in large cells, are also present. They are homogeneous, round in outline, from 8 to 12 μ in diameter.

In sections of liver tissue hardened in alcohol, when examined with a low power, an immense number of microparasites appear embedded in the tissue. These vary but slightly in size (8 to 9 μ). Throughout the invaded spot the blood vessels, large and small, are irregularly dilated and filled with red corpuscles, among which the parasites are not seen. The tissue between the blood vessels is no longer recognizable as hepatic tissue. In some parts of the section it consists in the main of the round parasites, single or in small groups, each individual or group inclosed in a rim of protoplasm provided with one or more nuclei. There is thus inclosing the parasites an imperfect meshwork present whose origin and nature is not evident. In some places it would appear that the parasites are embedded in the liver cell. The nuclei of such cells have undergone proliferation and some of these proliferated cells have degenerated into groups of minute, deeply-stained granules. The impression conveyed by such cells is that they are giant cells. They differ, however, from those giant cells which appear in a later stage of the disease. The meshwork of tissue which has undergone necrosis is present in but a few small areas.

Turkey No. 35.—From the same flock as No. 34 (and No. 21). Obtained August 18. Died on the way.

This case closely resembles the preceding. One-half the length of both cæca involved. The walls are thickened uniformly and in this portion are some small excrescences easily removed *in toto*, leaving only a slight depression.

Liver spotted on all surfaces as in preceding case. Duodenum blackish from injection and pigmentation. Muscular tissue has a yellowish tinge.

In the trachea one gapeworm, and some roundworms in the duodenum.

Turkey No. 36 (Farm N).—About 3 months old. Obtained, just dead, on August 18.

In this case the liver and cæca are diseased. The liver is spotted on all surfaces. The spots vary in appearance. A few have a mottled, pale-yellowish aspect and are fully 1.5 cm. (three-fifths inch) in diameter. The remainder are round blotches of a mottled, dark-brownish appearance. Many of these have coalesced into small groups.

The wall of the left cæcum is very slightly thickened and still smooth. The right is in the same condition. At the middle it has a circular ring-like thickening, about 2 cm. (four-fifths inch) wide, of a yellowish appearance on section. Sections were prepared of this region after hardening the entire cæcum in alcohol.

The thickened wall, about 8 mm. in diameter at the thickest portion, consists entirely of neoplastic tissue. The mucous layer is gone and the muscular layer is no longer recognizable. The bulk of the enlarged wall is composed of small cells, in which are interspersed in round and elongated patches large numbers of multinucleated cells, much smaller in size than the giant cells usually encountered. The cells do not distinctly show the microparasites within their substance except in a few cases, probably owing to the time and manner of hardening.

Turkey No. 37.—Obtained August 18 from Farm O. About 4 weeks old. Died the following night. No lesions found, although intestine contained many tapeworms.

Turkey No. 38.—From the same flock as preceding. About 3 months old. Died during the following night. No lesions. One gapeworm in trachea, and very many small tapeworms in intestine.

Turkey No. 39.—From the same flock. About 9 weeks old. Died the following night. Numerous tapeworms in intestine.

Turkey No. 40.—From the same flock August 18. Cooped until August 20. On that day the bird was resting on its breast with eyes closed. Killed. Many small tapeworms in intestine.

Turkey No. 41.—Probably 8 weeks old. Brought to laboratory August 18, 1894. Cooped temporarily and found dead August 20. Disease in this case limited to both cæca. (See page 22.)

Turkey No. 42.—Obtained August 18 from Farm I. About 3 months old. Suspected of being diseased. When killed no lesions were detected.

Turkey No. 43.—Obtained August 18 from Farm P. Cooped. Found dead August 20. The only discoverable lesions were a puffing out of the tissue below one eye, due to accumulation of a glairy secretion (roup). The same exudate found in the trachea. Agar tubes inoculated with tracheal exudate remained sterile. Numerous tapeworms in intestine.

Turkey No. 44.—Obtained from Farm Q August 18. Many turkeys are reported to have died on this place. Bird about 3 months old. No lesions found when it was killed. Many tapeworms in intestine.

Turkeys Nos. 45, 46, and 47.—Obtained from Farm R August 18 and cooped for several days. When killed nothing abnormal detected. A few tapeworms in the small intestine of No. 45 and No. 47, and many in No. 46. In the semiliquid contents of the cæca of No. 47 very many flagellates.

Turkey No. 48 (Farm S).—Obtained August 18. Cooped until August 21. Bird appears well. When killed a few tapeworms were found in the intestine.

Turkey No. 49.—Received August 18, from a dealer, the intestines of nine turkeys, In only one of these slight traces of cæcal disease. This is manifested by a nodular, roughened condition of the mucosa of one cæcum near the attached end. In all intestines tapeworms present.

Turkey No. 50.—Obtained September 26 from a farm in the District of Columbia. Slight odor of decomposition. The internal organs are free from disease. In the trachea one pair of gapeworms. The head is badly diseased. On the root of the bill a projecting tumor overlapping the nares, which is about two-thirds of an inch in diameter. It is of a soft, medullary character and has a wart-like structure. Besides this large tumor there is a small nodule on the lid of left eye. Right eye completely closed by excrescences on the lid and cheesy masses in conjunctival sac. Cornea opaque. In one nasal passage a large cheesy mass. No liver or cæcal disease.

Turkey No. 51 (Farm B).—Received from Mr. Cushman, Kingston, R. I., October 8, 1894. Died on the way. Turkey quite large; probably 5 months old. Decomposition well advanced. The disease in this case was limited to the cæca, the liver, and the peritoneum. The intestine was covered in places by a firm, yellow pseudomembrane fully 1 mm. thick, and the coils were glued to each other so that they could be separated only after much dissection. The cæca appeared as an irregular mass partly covered with the pseudomembrane. Attempts to dissect out both cæca were fruitless, as they were firmly attached to each other. Only one was diseased, however. This was much enlarged, its walls thickened, and the mucous membrane beset with large, firm masses of exudate. In the liver were two foci of disease, each about 1 cm. in diameter. One is made up of firm, pale-grayish tissue, probably largely cicatricial; the other is similar in appearance, but has small, yellow, cheesy masses disseminated through it.

Owing to the very advanced stage of decomposition, cultures were not made. It was evident, however, that the cause of death was the septic peritonitis, which was secondary to the cæcal disease.

Turkey No. 52.—Received, dead, with No. 51. Large male bird; probably 5 months old. Very little decomposition.

Head free from disease. Heart and lungs normal. The pleuroperitoneal cavity contains a large amount of blood-stained serum. Serous coat of gizzard very much injected.

Serous coat of proventriculus dotted with elevated yellowish points and lines where the diseased liver lay in contact with it. Spleen small, contains a minute yellow focus; probably also the result of neighboring disease of the liver.

Duodenum, and a portion of the intestine below it, intensely hyperæmic and pigmented. A few small tapeworms present. Pigmentation and hyperæmia gradually become less and disappear near openings of cæca. Below these the intestine is coated with a yellowish liquid, largely composed of urates.

Both cæca contain pigment spots, and the longitudinal folds are pigmented. In one cæcum, near the blind end, there is a thickening of the wall about half an inch across, covered with a brownish-yellow slough on the mucous side. The serous aspect is discolored, in part yellowish. This is the only lesion found in the cæca.

The liver is very large, weighing 304 grams (10.7 ounces). It is extensively diseased. The lesions are best described by grouping them under several heads:

(1) Necrosis of the liver tissue is present in both lobes in the form of large and small masses of yellow, firm, cheesy masses (Pl. III, fig. 2). In the left lobe fully one-third of the lobe is converted into a single, yellowish, homogeneous mass, situated at the base or attached portion. The necrosed tissue is sharply defined from the adjoining living tissue by an irregular line. The main branch of the hepatic vein is bounded by the necrosed tissue, and the branches from the dead mass are occluded with pale, friable thrombi. In the right lobe, at the base or attached portion, there are several quite large cheesy masses of very irregular outline embedded in the living tissue and in part visible on the surface. Besides these large masses there are disseminated through the liver numerous smaller masses of cheesy tissue, either singly or in groups. These small foci are usually associated with reparative processes.

(2) Foci which have healed and cicatriced wholly or in part are represented by isolated regions, varying in size and attaining a diameter in one case of three-fourths of an inch. The appearance of these foci varies considerably. They may show as pale pinkish-gray spots penetrated by a network of vessels corresponding to the interlobular markings. Others may be the seat of scars and slight depressions characterized by increased vascularity and a pale pinkish-gray appearance on the liver tissue. Finally, they may be intermingled with small cheesy foci, which are located either centrally in the healed region or in numerous foci around it.

Over the entire surface of the liver patches containing networks of enlarged vessels having a blackish color give the liver an injected appearance. There is nowhere an indication that the disease as such is still going on. The extensive destruction of liver tissue, as well as the repair, appear to be the result of an invasion of protozoa now completely checked.

The false membranes which cover some of the healing spots on the liver and the abundant fluid in the abdominal cavity indicate a secondary infection with bacteria through the necrosed tissue.

A PRELIMINARY INVESTIGATION OF DIPHTHERIA IN FOWLS.

By **Veranus A. Moore.**

[With Pl. VI.]

It is well known that a disease which is characterized by the formation of an exudate on one or more of the mucous membranes of the head is widely distributed among the fowls of this country. Although its existence is of long duration its cause and the character of the exudate have not been satisfactorily determined. In Europe outbreaks of a malady comparable to this in their manifestations have been described as epizootics of fowl diphtheria. There are in this country a few popular articles on diphtheria in fowls, but, generally speaking, the term most frequently employed to designate a disease on the heads of poultry is "roup."[1] The range of morbid anatomy which this term originally indicated is not known, but its present conception is exceedingly broad, including, as shown by the American literature,[2] nearly, if not all, the noticeable disorders of the heads of poultry.

Writers differ in reference to the nature of this disease. Many poultry raisers consider it a local affection, having its origin in the improper care of the fowls, while others insist that it is a highly contagious disease. The latter class strengthen their position by clinical history, in which they show that fowls which had previously been free from this disease soon became infected after the introduction of one or more "roupy" fowls into their midst. Reports show that it is the usual experience that when the disease is introduced it almost invariably remains in a more or less chronic form for an indefinite period, notwithstanding the adoption of the best known methods of caring for the fowls. It is stated by Bennett that "it is undoubtedly transmitted from the sick to the well fowls by their drinking out of the same vessel, as the discharges from the nostrils of the sick birds contaminate the water as they drink."

---

[1] The origin of this term is somewhat obscure, but it is supposed to be a corruption of croup, and its application explained on account of a peculiar hoarseness accompanying the respiration of the affected birds.

[2] This literature is confined for the greater part to articles in poultry and agricultural papers and journals. They are written by poultry fanciers or farmers, who record their experience with the various diseases of fowls, and, as would be expected, they deal more with the treatment than etiology, and while suggestive are of little value in the study of the cause and nature of the maladies of which they treat.

The lesions and symptoms attributed to this disease are exceedingly variable. Among the more careful writers we find "roup" defined as "a purulent catarrhal affection of the air passages." The localization of the lesions, however, in the air passages is not universally supported. It is usually stated to affect, to a greater or less extent, the conjunctiva and the mucosa of the mouth, pharynx, and larynx, as well as that of the nares. The first symptoms are said to be "dullness and loss of appetite, discharge from the nostrils, loud breathing, and a dry cough." This is followed by the appearance of an exudate on the mucosa of the nares, which extends in all directions, often covering the eyes with a cheesy substance. The secretions are said to occasionally accumulate within the sides of the face, causing them to swell to an extensive degree. The appetite is either very poor, or ravenous, in which case the food is not digested. Emaciation follows and death may occur in from three to eight days, or, as is usually the case, the disease becomes chronic and the fowls eventually recover.

The economic importance of fowl diphtheria appears to be greater than that of any of the other poultry diseases. There are no statistics, however, by which the total amount of loss from this cause can be even approximately obtained, but the numerous reports of its occurrence are sufficient to show that it is very large. Unlike a rapidly fatal disease such as cholera, the loss is not confined to the fowls which die, but in addition it includes a heavy shrinkage in the poultry products, due to the chronic course of the disease in large numbers of fowls which eventually recover. The small value of the individual and the fact that only a small percentage of those affected die has evidently caused the importance of the disease to be underestimated. It is evident, however, that the frequency of its occurrence and its wide geographical distribution render this affection a serious obstacle to the poultry industry[1] of this country. In addition to the usual chronic form, there are, if reports are true, frequent epizootics in which thousands of dollars' worth of poultry are destroyed.

In addition to the theory of contagion, there are many conditions mentioned in poultry literature under which this disease may be expected to occur. Thus, it is affirmed that fowls exposed to a draft at night will ordinarily become affected. The nature of the food, ventilation, and cleanliness are also considered important factors in producing or preventing this malady. The exudates are described as both catarrhal and diphtheritic, but the description of the lesions is exceedingly indefinite.

---

[1] The economic importance of this industry is little understood. The Eleventh Census shows that in 1890 there were in the United States 258,472,155 barnyard fowls (exclusive of ducks, turkeys, and geese), and that the egg product for 1889 was 817,211,146 dozens with a money value of $98,000,000.

The foregoing résumé of the present knowledge of the disease generally designated as "roup" is important in showing the various conditions recognized and included under that term. There are other so-called fowl diseases, such as influenza and distemper, reported to be characterized by somewhat similar symptoms and lesions. Their descriptions are so indefinite, however, that it is impossible to differentiate them from certain forms of the disease more frequently called "roup," but which, on account of the nature of the lesions, will be considered as diphtheria in this preliminary report.

I.

During the past year numerous reports of epizootics among poultry[1] have been received, and several sick and dead fowls have been sent to this laboratory and to the experiment station of this Bureau for examination and diagnosis. Certain of the sick fowls improved rapidly and soon fully recovered. Others were dead and far advanced in post-mortem changes when received, while a few were in a condition more suitable for bacteriological and pathological study.

In all, about 36 fowls came under observation. Several of them subsequently recovered; a few died with tumors; in one case death was undoubtedly due to a traumatism;[2] 2 died of fowl cholera, and the remainder, 18 in number, were affected with somewhat similar lesions of the mucous membranes of the head, although they came from reported epizootics of cholera, diphtheria, and "roup." The examination of these fowls revealed the interesting fact that the lesions corresponded very closely to those described by Loeffler,[3] Klammer,[4] Babes and Puscariu,[5] Eberlin,[6] Loir and Ducloux,[7] and others, as diphtheria in pigeons, fowls, and other birds.

As the disease was not studied in the field it is impossible to define the conditions under which it occurred, or to estimate the full extent of the loss it occasioned. The fowls examined and here reported came from five different flocks, in some of which there is a history of contagion. Unfortunately, the fowls sent to us were usually among the last to be affected.

The methods employed have varied according to the exigencies of the different cases. In order, therefore, to present the facts obtained in these preliminary studies, it seems best to record somewhat briefly the history of each outbreak, so far as determined, together with the notes on the individual fowls.

---

[1] In addition to the fowl disease, a similar affection of pigeons, more particularly of young squabs, was reported from Waynesboro, Pa., and several of the affected birds were sent to this laboratory for examination. The lesions found in these birds resemble somewhat closely those found in the mouths of fowls.

[2] It is not uncommon to find pieces of wire or nails in the crop and proventriculus. In one case, two eight-penny nails and a piece of wire about 2 inches long were found piercing the walls of the proventriculus and penetrating the liver and lungs.

[3] Mittheilungen aus dem Kaiserlichen Gesundheitsamte, Bd. II (1884), S. 421.

[4] Berliner thierärzt. Wochenschrift, 1890, No. 18, S. 138.

[5] Zeitschrift f. Hygiene, Bd. VIII (1890), S. 374.

[6] Monatshefte f. Thierheilkunde, Bd. V (1894), S. 433.

[7] Ann. de l'Inst. Pasteur, Tome VIII (1894), p. 599.

OUTBREAKS.

I.

Late in December, 1893, Mr. W., of Middleport, N. Y., sent several adult fowls[1] affected with "roup" to the experiment station of this Bureau. Mr. W. stated that he had lost a considerable number of fowls from this disease during the past two or three years. He believed that the disease was introduced into his flock by the purchase of some choice birds about three years before. Since its first appearance it had continued to exist in his flock, usually running a chronic course, but occasionally breaking out in a more acute and destructive form. He had tried many methods of treatment without success.

The majority of the fowls sent by Mr. W. appeared to be well upon their arrival at the experiment station. A few of them were killed for examination and found to be normal throughout. Five fowls, however, were suffering with a slight or more extensive exudate on the nasal mucosa, or conjunctiva. These were carefully watched and examined from time to time with the results indicated in the appended notes.

Fowl No. 1.—This fowl was suffering from an exudate in the left eye. December 25 Dr. Smith made several cultures from this exudate. From these two nonpathogenic bacilli were isolated.

December 28: A portion of the exudate was removed from the eye of fowl No. 1 and inserted beneath the skin, over the abdomen, of a rabbit. On the following day there was considerable swelling at the point of inoculation. This continued for several days, when it subsided. The rabbit died February 10, 1894. It was very much emaciated, but no bacteria were found in the organs, either in cover-glass preparations or in cultures.

January 25, 1894: Fowl No. 1 was found dead; very much emaciated. The left eye was covered with a thin layer of a friable, yellowish exudate, composed of broken-down cells and bacteria. No fibrin discovered. The nictitating membrane thickened; cornea opalescent. The mucosa of the nares, mouth, and pharynx were apparently normal. No lesions were found in the internal organs. Culture media inoculated with small pieces of the liver remained clear.

Two white mice were inoculated subcutaneously with bits of the exudate from the eye. They died on the fourth and sixth days, respectively, after the inoculation.

From the organs of the mouse which died on the sixth day a nonmotile bacillus, resembling morphologically and in its cultural characters the bacillus of rabbit septicæmia, was isolated. Experimental animals inoculated with small quantities of culture remained well. This bacillus was carefully studied and retained in subcultures until the fall of 1894, when a rabbit inoculated intravenously with a moderate quantity of pure culture died on the second day with lesions similar to those produced by the slightly attenuated bacillus of rabbit septicæmia.

---

[1] The term fowl is used in this article in its restricted sense, referring to *Gallus domesticus* only. This disease, however, is said to affect several other species.

The mouse which died on the fourth day exhibited an enlarged and discolored spleen. The other organs were normal in appearance. A cover-glass preparation showed it to contain a large number of bacilli. Tubes of agar and bouillon inoculated with bits of the spleen pulp developed into pure cultures of a motile bacillus, which was subsequently found to be possessed of marked pathogenic properties. Although fatal to such a large number of experimental animals, experiments to produce a disease in fowls similar to the one from which it was obtained gave negative results.

Notwithstanding the marked pathogenesis of this organism, its cultural and physiological manifestations showed it to be closely related to *Bacillus coli communis*,[1] though differing from it in several important particulars.

Fowl No. 2.—January 4, 1894: This fowl appeared to be well excepting a protuberance beneath the left eye. In order to examine this thoroughly the fowl was killed with chloroform. The autopsy showed much emaciation. The protuberance consisted of an encysted tumor lying immediately beneath the conjunctiva. It was about 2 cm. long and about one-half as thick. Upon section it was found to contain a yellowish, caseous substance, which emitted a peculiar, penetrating, and repulsive odor. The nasal duct was clear. The eye itself was not visibly affected. The liver was unusually fatty. In the left lung were a few hepatized areas. Other organs appeared to be normal.

Cover-glass preparations made from the caseous substance contained many bacteria. Those from the other organs showed no microorganisms. From the caseous substance a large number of cultures were made in agar, bouillon, glycerin-agar,

---

[1] On account of the importance of considering all bacteria possessed of pathogenic properties, of however slight degree of virulence, the more significant characters and properties of this bacillus are appended.

Morphology.—A small, actively motile bacillus, varying in length from 1.2 to 2 μ, ends rounded. It is appreciably larger in bouillon than in agar cultures. Flagella easily demonstrated. Stains readily with the ordinary aniline dyes.

Culture characters.—On agar it develops in twenty-four hours into a moderately vigorous, moist-appearing, glistening growth of a neutral grayish color. The growth is not viscid. When isolated the colonies are round, slightly convex, varying from 1 to 3 mm. in diameter. In gelatin the growth is very feeble in stick cultures. After forty-eight to seventy-two hours a delicate grayish growth appears along the needle track. The colonies in plate cultures appear on the second day as minute grayish points. On potato the day after inoculation at 36° C. a light, lemon-yellow colored growth appears. At the end of from four to six days the growth has increased slightly in quantity; the color is somewhat darker. When cultivated in peptonized bouillon the fluid becomes heavily clouded in twenty-four hours. After about three days a thin, friable, grayish membrane forms over the surface of the liquid. The reaction, which at first is faintly alkaline, becomes slightly acid, but subsequently strongly alkaline. It does not grow in acid bouillon.

The casein of milk is precipitated in from two to three days. It is faintly acid in reaction. In about seven days the casein becomes firm and covered with a clear serum.

Its action upon sugars is very constant. Dextrose and lactose are fermented with the formation of gas. In both cases 46 per cent of the capacity of the closed branch of the fermentation tube is filled with gas. The proportion of CO_2 to the H in the gas varies slightly with the two sugars; in the dextrose it is 3:11, in the lactose 4:11. The production of gas is completed in from three to four days. Fermentation tubes containing saccharose bouillon become uniformly clouded throughout, strongly alkaline in reaction, but no gas is formed.

A marked indol reaction was obtained.

Pathogenesis.—When isolated this organism was fatal to white mice in from twenty-four to forty-eight hours when inoculated subcutaneously with from one to gelatin, blood serum, bouillon containing glucose in fermentation tubes, and anaërobic-agar cultures. From these two aërobic bacilli and one streptococcus were isolated, all of which were harmless for experimental animals.

Fowls Nos. 3, 4, and 5.—When received these fowls exhibited a very slight quantity of a mucus-like exudate in the nasal cavities. They were thought at the time to be the best cases for an experiment to test the contagiousness of the disease, and very soon after their arrival they were penned with six healthy fowls.

February 21, 1894: About seven weeks later, rabbit No. 144 was inoculated subcutaneously with a loop of the nasal discharge of fowl No. 3. February 23 the rabbit was found dead. The autopsy showed a slight purulent infiltration into the subcutaneous tissues at the point of inoculation. The spleen was slightly enlarged and of a dark, purplish color. The liver was hyperæmic, and the cortex of the kidneys deeply reddened, due to injected blood vessels. There were several punctiform hemorrhages beneath the serosa of ileum and lower colon. The lungs were markedly emphysematous. Stained cover-glass preparations made from the blood, spleen, and liver showed innumerable short rod-shaped bacteria with ends rounded, usually exhibiting light or unstained centers. Pure cultures of this bacillus were obtained from the spleen and blood.

February 24: A second rabbit (No. 145) was inoculated subcutaneously with the nasal discharge. It was found dead at 4 p. m. February 25. The autopsy and bacteriological examination revealed the same condition and results as those described for rabbit No. 144.

Fowl No. 3.—February 25: This fowl was found dead. It was very much emaciated. The nasal cavities were occluded with a thick muco-purulent substance. At the external nares it had a yellowish color and was dried down into a firm, crust-like mass. Throughout the nasal passages to the posterior opening the substance was lighter in color and very viscid. The eyes were not affected. The internal organs appeared to be normal. Tubes of culture media inoculated from the liver and blood remained clear. The fact that two rabbits had been recently inoculated from the nasal discharge with like fatal results precluded the necessity of further inocula-

---

two drops of a pure bouillon culture. The lesions were characterized by œdema about the place of injection, and an enlarged and discolored spleen. Gray mice remained well after a similar injection.

A short series of inoculations were made in white mice, and gray mice succumbed to the inoculation with a culture from the spleen of the second white mouse that died. The lesion found was a much enlarged spleen as in white mice.

A guinea-pig inoculated in the abdominal cavity with 0.3 cc. of a bouillon culture was found dead on the following morning. The abdominal organs were covered with a grayish exudate, which was in the form of shreds over the intestines. A few ecchymoses beneath the pleura and peritoneum. The peritoneal exudate ontained innumerable bacteria.

Rabbits are not susceptible to subcutaneous or small intravenous injections of pure cultures.

A fowl inoculated in the wing vein with 0.3 cc. of a bouillon culture died on the second day. The organs contained very few bacilli. Tubes of culture media inoculated with bits of the liver developed into pure cultures of this bacillus.

A fowl inoculated subcutaneously with 0.6 cc. of a bouillon culture died in forty-four days. No bacteria were found in the organs and no lesions were discovered. The cause of death is questionable.

A large number of inoculations were made beneath the conjunctiva of fowls, but no lesions were produced. Loops of the growth from agar cultures were rubbed cover the conjunctiva and into the nasal cavities with negative results.

Four fowls were fed with 240 cc. of bouillon cultures of this bacillus mixed with a little mill food. They remained perfectly well.

tions at this time. The bacillus obtained from rabbits Nos. 144 and 145 was exceedingly abundant in the nasal discharge, and especially so in preparations made from scrapings of the nasal mucosa.

Fowl No. 4.—This fowl had presented external appearances similar to those of fowl No. 3.

February 24: Rabbit No. 97 was inoculated subcutaneously with a loop of the nasal discharge. It was found dead on the following morning. The examination showed its organs to contain innumerable bacteria identical with those found in rabbits inoculated from fowl No. 3.

Fowl No. 5.—Like Nos. 3 and 4, this fowl suffered apparently from a nasal catarrh. The eyes and mouth were normal.

February 28: Rabbit No. 149 was inoculated with the nasal discharge. The rabbit died in less than twenty-four hours from septicæmia, the same as the rabbits inoculated from fowls Nos. 3 and 4.

Fowls Nos. 4 and 5 died soon after the inoculations into rabbits were made. They were not brought to the laboratory, but examined at the experiment station by Dr. F. L. Kilborne, who reported them to be much emaciated and the nasal cavities filled with a muco-purulent substance. The bacteria obtained in pure cultures from the rabbits inoculated from fowls Nos. 3, 4, and 5 were carefully studied and compared and found to be identical in morphology and cultural characters and to resemble the bacillus of rabbit septicæmia. The bacillus obtained from fowl No. 1 was not distinguishable from it except in its degree of virulence.

The six fowls penned with fowls Nos. 3, 4, and 5 from the latter part of December, 1893, until the middle of February, 1894, remained perfectly well. The disease in the affected ones remained confined to the nasal cavities. In this experiment all the fowls drank from a small basin, and their food was kept in a dish arranged so that they were all compelled to eat from it. The disease was not contracted by the exposed fowls.

II.

In October, 1894, four fowls were received from Mr. W., of Newbern, N. C. In an accompanying letter he stated that they were suffering from a disease which was called cholera, and which had killed hundreds of fowls about Newbern during the summer and early fall.

All of the fowls (Nos. 65, 66, 67, and 68) were adults of a mixed breed. Upon inspection two of them were found to be apparently well and the other two were suffering from an exudate over the conjunctiva of one eye and the mucosa of the nasal passages. As this disease was reported to be contagious it was thought that the apparently well fowls (Nos. 66 and 67) had simply been exposed, and consequently they were kept for a considerable time waiting for the disease to develop. They were subsequently chloroformed and carefully examined, but no lesions were found in either case, and culture media inoculated with pieces of the organs remained clear.

Fowl No. 65 was chloroformed soon after its arrival and carefully examined. It was much emaciated. The left eye was covered with a thick yellowish exudate, which was somewhat elastic. The microscopic examination showed small and large round cells and bacteria. A fibrin-like substance was present in moderate quantities. The exudate was firmly attached to the cornea but not to the conjunctiva covering the inside of the lids. The mucosa of the nares and mouth appeared to be normal. The intestines were slightly reddened, due to injection of blood vessels. They contained a large number of roundworms and several tapeworms attached to the mucosa. In the intestinal wall were several nodules.[1] The other organs appeared to be normal.

Tubes of culture media inoculated with the liver remained clear. A tube of agar inoculated with the exudate from the eye developed into a pure culture of a motile bacillus belonging to the colon group of bacteria.

Fowl No. 50 was inoculated in both eyes with bits of the exudate from the eye of fowl No. 65. The mucosa of the conjunctiva over the lower lids were scraped and the exudate thoroughly rubbed into the irritated surface. The inoculation wound healed rapidly and the eyes subsequently remained well.

Fowl No. 68 was chloroformed and examined November 9. Fowl very much emaciated. The left eye was covered with a cheesy, yellowish, rather firm exudate, which formed a cap over the eye and which was easily removed. It emitted a strong putrid odor. The eye was much flattened and the cornea had an opalescent appearance. The posterior portion of the eye was normal. The saucer-shaped exudate was loosely attached to the conjunctiva over the lids and cornea. There was a small amount of firm cheesy exudate in the nasal cavities. The mucosa of the mouth and pharynx was normal in appearance. The liver, spleen, kidneys, intestines, and lungs also appeared to be normal. Although the fowl was emaciated, it is highly probable that the exudate in the eye would soon have sloughed and that recovery would have followed. The appearance of the nasal mucosa indicated that the cheesy substance in the nasal passages had come from the eye, having coagulated after passing through the lachrymal duct. The disease appeared to be localized in the left eye.

Fowls Nos. 54 and 55 were inoculated by scraping the mucosa of the conjunctiva and pharynx and thoroughly rubbing the irritated surface with the exudate from the eye of fowl No. 68. The inoculation wound healed and the fowls remained well. About ten days later they were reinoculated in a similar manner with the growth from an agar culture made from the eye of fowl No. 68. No lesions were produced.

III.

In the fall of 1894 several chickens suffering from this disease were examined from the flock belonging to Mr. T., who resided near Alexandria, Va. The insidious nature of certain forms of this malady is well illustrated by this outbreak. Several healthy young chickens were desired for experimental purposes, and Mr. T. reported that he possessed some very thrifty chickens of the desired age, and his account of the history of his fowls showed that the place had been free from fowl diseases for several years. Nine of the chickens were secured and placed on the experiment station. A few days later two of them were brought to the laboratory, where, upon inspection prior to their use, they were found to be suffering with an exudate which covered the greater part of the mucosa of the mouth and pharynx. The other seven chickens were examined by Dr. Schroeder, director of the station, who found a few of them to be similarly affected. The remainder appeared to be well, but were subsequently attacked. Some of these were allowed to die, and others were killed in the earlier stages of the disease for examination. Mr. T. states that later in the fall he lost a few chickens from this disease, and a large number were affected which recovered.

---

[1] During the summer of 1894 numerous fowls were found to be affected with a disease of the intestines, due to the presence of tapeworms. This disease is especially interesting, owing to the resemblance of its lesions to those of tuberculosis. I have described it somewhat fully in an article entitled "A Nodular Tæniasis of Chickens," to appear in a forthcoming report of this Bureau.

Fowl No. 60 was brought to the laboratory October 17. On the following day it was found sitting in a crouched position, feathers ruffled, and the head drawn close to the body. It breathed through the mouth. The eyes were usually closed; no exudate on the conjunctiva; temperature 108° F. The symptoms apparently improved during the next few days, but on the morning of October 22 it was found dead. This chicken was about 2 months old and was much emaciated. On the lower side of the cornea of the right eye there was an area about 2 by 1 mm. covered with a grayish exudate loosely attached to the cornea. The mucosa over the entire left side of the mouth was covered with a yellowish exudate one-fourth to 2¼ mm. in thickness. It was easily removed and exceedingly friable. The mucosa of the pharynx, larynx, and nares was normal. The internal organs appeared to be normal. Cultures made from the exudate, liver, and kidneys contained a variety of bacteria, which, however, were not isolated and studied in pure culture.

Fowl No. 59 was received at the laboratory at the same time, and it manifested symptoms similar to those described for No. 60. After a few days the symptoms showed a general improvement, which continued until October 20, when it was chloroformed for examination.

The autopsy showed the fowl to be very much emaciated. The mucosa of the nares and the conjunctiva was normal. On the floor of the mouth, on each side of the tongue and extending back on either side of the larynx, there was a band of grayish exudate about 2 mm. in width, firmly adhering to the mucosa. In microscopic section the exudate was found to be composed for the greater part of round cells and bacteria. (See Pl. VI, fig. 3.)

The internal organs were normal in appearance. Tubes of agar inoculated with bits of the liver and kidney developed into cultures containing several forms of bacteria, including a micrococcus frequently encountered and *Bacillus coli communis.*

A guinea-pig was inoculated subcutaneously with a small piece of the exudate, including subjacent muscle. A small swelling developed at the place of inoculation. Five days after inoculation the guinea-pig was chloroformed and examined. At the place of injection the subcutis was infiltrated with a pasty, purulent substance over an area of 5 by 3 cm. The adjacent muscle necrosed. Thoracic and abdominal organs normal in appearance. No bacteria were found in cover-glass preparations and subsequently in cultures made from the organs. The pus in the local abscess contained innumerable bacteria, apparently of the same species. Bouillon and agar inoculated from the infiltrated substance developed into pure cultures of a nonmotile bacillus, which was carefully studied and found to be similar in its pathogenesis and cultural characters to that of slightly attenuated rabbit septicæmia.

Fowl No. 69.—In the latter part of October this fowl was attacked, and a thick exudate formed on the larynx. November 2 it was chloroformed. The eyes were covered with exudate which agglutinated the lids. Upon opening the lids the exudate was easily removed from the conjunctiva covering the lids, but it was firmly attached to the cornea. The exudate formed saucer-shaped caps which covered the eyes, being 2 mm. thick over the cornea, gradually thinning out to a sharp margin. About the margin of the firm exudate was a small quantity of partially coagulated mucous substance. The mucosa of nares normal. On both the anterior and posterior sides of the laryngeal opening there was an area about 3 mm. in width covered with a grayish exudate adhering firmly to the mucosa. It was removed with difficulty, leaving a raw surface. The kidneys were mottled with grayish lines, due to large quantities of urates in certain of the tubules. Other organs appeared to be normal.

November 2: Rabbit No. 215 was inoculated subcutaneously with a small quantity of the coagulated mucus from the eyes.

November 5: Rabbit found dead this morning. At the point of inoculation the subcutis was infiltrated with a purulent substance over an area 2 by 5 cm. The pleura over the lungs and parietes was covered with a thin cellular exudate. Lungs hyperæmic. Spleen much enlarged and dark colored. Kidneys hyperæmic. The liver mottled with areas covered with a delicate grayish exudate. The mucosa of the lower colon sprinkled with punctiform hemorrhages. Cover-glass preparations from the organs contained innumerable short bacilli with ends rounded. Polastain not marked.

Rabbit No. 225 was inoculated with 0.3 cc. of a bouillon culture obtained from the spleen of rabbit No. 215. It was found dead on the fourth day with lesions similar to those found in rabbit No. 215. Stained cover-glass preparations made from the liver and spleen contained innumerable polar-stained bacteria. Pure cultures or this organism were obtained from the liver. A guinea-pig inoculated into the abdominal cavity with 0.3 cc. of a bouillon culture from rabbit 215 died within twenty four hours. A subcutaneous inoculation with a similar quantity produced death in six days.

Fowl No. 70 was received at the same time as No. 69 and chloroformed for examination. Much emaciated. The left eye was closed, the lids agglutinated together; the eye was covered with a yellowish cheesy exudate adhering quite firmly to the cornea. It gave off a disagreeable odor. The exudate had sloughed from the conjunctiva of the lids. In the nasal passages there was a small amount of cheesy exudate. Mucosa of mouth normal. The internal organs appeared to be normal. No cultures were made.

Fowl No. 71 was found dead November 5. This fowl was much emaciated. The left conjunctival sac contained considerable semiliquid substance. The mucosa was slightly reddened and the cornea had an opalescent appearance. No other lesions were found. Cultures made from the exudate in the eye contained several forms of micrococci and a short nonmotile bacillus.

Rabbit No. 223 inoculated subcutaneously with the liquid from the eye.

November 12 the rabbit was found dead. The autopsy showed extensive purulent infiltration into the subcutaneous tissue about the point of inoculation. The thoracic and abdominal organs were covered with a thin grayish exudate composed of cells and bacteria. Spleen enlarged; pulp soft. No bacteria were found in cover-glass preparations from the organs, but in those from the exudate there were innumerable short bacilli with ends rounded, frequently exhibiting a polar stain. Pure cultures of this bacillus were obtained from the spleen and liver.

November 14: Fowl No. 64 was inoculated in the conjunctiva with 0.2 cc. of a bouillon culture of the bacillus obtained from fowl No. 71. On the following day there was much swelling of the eyelid. The swelling increased, with accompanying reddening, for about two days, when it began to subside and finally entirely disappeared. The fowl continued well.

November 14: Fowl No. 65 (previously inoculated on the mucosa of head) was inoculated in the wing vein with 0.3 cc. of a fresh bouillon culture of this bacillus. The fowl remained well.

Two small chickens were inoculated beneath the mucosa of the mouth and also the conjunctiva with several drops of a pure culture of this bacillus without producing any appreciable effect.

Fowl No. 72 was found dead November 7. It was much emaciated. A thin grayish substance covered the cornea from which a nonpathogenic bacillus was isolated. No lesions could be found, and culture media inoculated from the organs remained clear.

Fowl No. 73 was found dead November 9. It was much emaciated. The conjunctiva and mucosa of the nares were normal. The roof of the mouth and the pharynx were covered with a thick grayish exudate, which was removed with difficulty, leaving a raw surface. The entire tongue was surrounded with a thick exudate, which was easily removed. The examination of sections showed a cell infiltration extending through the mucosa into the subjacent muscles. No other lesions were found. On account of a scarcity of rabbits no inoculations were made from this fowl.

Fowl No. 75 was found dead November 22. Fowl considerably emaciated. The left eye was covered with a thick necrotic exudate, which was easily removed from both the eye and conjunctiva of the lid. The exudate extended through the nasal duct into the nares. In the posterior nares the exudate was bordered by a layer of a grayish, mucus-like substance. Small areas on the roof of the mouth and about the glottis were covered with a grayish, firmly-adhering exudate, which left a raw surface upon removal. No other lesion discovered.

November 22: Rabbit No. 226 inoculated subcutaneously with the mucus-like substance from the nares.

November 23: Rabbit found dead this morning. Owing to the large amount of exudate injected beneath the skin the local lesion was unusually severe. The abdominal viscera were hyperæmic. Cover-glass preparations made from the organs contained many elongated bacteria. A pure culture of a nonmotile bacillus was obtained from the liver. A rabbit inoculated subcutaneously with 0.3 cc. of this culture died of septicæmia in less than twenty-four hours. This bacillus was identical in its morphology and cultural characters with those obtained from fowls Nos. 59, 69, and 71.

IV.

In October, 1894, a severe epizootic was reported to have occurred among fowls belonging to Mr. P., residing on Bennings road, in the District of Columbia. Mr. P. stated that a considerable number of his fowls had died from what he thought to be diphtheria, on account of the grayish membrane observed on the mucosa of the mouth and pharynx. Unfortunately, he did not notify us of this disease until it was nearly over, so that we had an opportunity of examining only the three last fowls affected. Two of these were not received until some time after death, and the other died on the third day after its arrival. The results of these examinations are appended:

Fowl No. 58.—This fowl was received at the experiment station October 9. It was found dead on the morning of October 12. Fowl very much emaciated. The mucosa of nares, mouth, and pharynx appeared to be normal. No lesions were found in the internal organs excepting a few nodules due to certain forms of tapeworms in the intestine. Cover-glass preparations of the blood and liver showed no bacteria. In those from the kidney a very few short bacilli with rounded ends were observed. Tubes of bouillon were inoculated with bits of the blood, liver, and kidney. The tubes inoculated with the blood and liver developed into impure cultures of ordinary saprophytic bacteria. The culture from the kidney contained a short motile bacillus belonging to the colon group.

Fowl No. 61.—A small chicken, about 10 weeks old. It had been dead about twenty-four hours when received. Much emaciated. Along the cleft in the hard palate there was a narrow strip covered with a thick grayish exudate, which was firmly adherent to the mucosa. On the posterior surface of the pharynx and also about the glottis were small areas covered with a similar exudate. The left eye was covered with a firm, yellowish mass of necrotic exudate, which was easily removed. The color of the internal organs was slightly altered, due to post-mortem changes; otherwise they appeared to be normal.

A guinea-pig was inoculated subcutaneously with a bit of the exudate, including the subjacent tissue from the roof of the mouth. A slight swelling occurred at the point of inoculation. Four days after the inoculation the guinea-pig was chloroformed and culture media inoculated from the local lesion. These developed into pure cultures of a motile bacillus belonging to the colon group.

Fowl No. 62.—This fowl was received at the same time as No. 61. The lesions were confined to the nasal passages, which were occluded with a yellowish cheesy substance, and the left eye, which was covered with a quite firm, easily removable necrotic exudate. The conjunctiva of the lids were not appreciably affected. The cornea was opaque.

A guinea-pig was inoculated with a portion of the exudate from the nasal cavities. It was chloroformed six days later for examination. The subcutaneous tissue about the point of inoculation was infiltrated with a purulent substance over an area of about 1 cm. in diameter. No other lesions. From the local lesions pure cultures of a motile bacillus belonging to the colon group were obtained.

V.

This outbreak occurred among the fowls belonging to Mr. H., who resides at Brookland, D. C. He states that he had about 75 fowls, all of which were in excellent condition up to the purchase of a cock, which was subsequently found to be diseased. A large number of his fowls became infected. They usually recovered, although several of the badly affected ones were killed. Late in October Mr. H. brought a hen which was suffering from the disease to this laboratory. This was one of the last of his fowls to be attacked. At the time it came under my observation the disease was confined to the left eye and an area of firmly attached exudate on the roof of the mouth. This fowl was kept under observation for several weeks, and cultures and animal inoculations were made from the exudate as indicated in the appended notes.

Fowl No. 63.—Received October 20. The left eye was considerably swollen, the two lids being agglutinated together. The cornea had an opalescent appearance. Respiration apparently normal. Temperature 107° F. Fowl sits with the head drawn close to the body. Tubes of agar and bouillon inoculated with the exudate developed into pure cultures of a nonpathogenic micrococcus.

A white mouse was inoculated subcutaneously with a loop of the exudate from the eye. It remained well for about three weeks, when it died. As it was badly decomposed when examined no cultures were made.

Fowl No. 64 was again inoculated in both eyes with the exudate from the eye of this fowl. The exudate was thoroughly rubbed on the conjunctiva. Four days later the inoculation was repeated. The eyes remained apparently perfectly well.

October 22: A guinea-pig was inoculated into the abdominal cavity with 0.4 cc. of a bouillon culture from the eye exudate. It remained well.

October 24: The left eye of fowl No. 63 was covered with a quite firm, nearly white exudate, which causes it to protrude considerably. The lids were firmly agglutinated together, being separated with much difficulty. The lid was lined with a thick, quite firm, whitish exudate. Nictitating membrane much thickened. There were several areas of a grayish exudate in the roof of the mouth. Cultures in agar and bouillon made from the eye contained two species of micrococci. The growth in the agar consisted of a few colonies only.

A white mouse inoculated with the exudate was found dead on the third day. From the liver a culture of a micrococcus was obtained. This organism did not prove fatal in subsequent inoculations.

October 27 the eye was entirely closed. The agglutinated lids were separated and a wedge-shaped mass of necrotic exudate was easily removed. This covered the entire inner surface of the lower lid, being thicker at the exposed or free margin.

In section it was found to be composed very largely of broken-down cells. The cornea had an opalescent appearance and was decidedly flattened. A nonpathogenic bacillus was obtained in agar cultures from the eye.

November 9, the fowl appeared to be improved. The eye was covered with a yellowish exudate which emitted a peculiar, offensive odor. It was easily removed leaving a roughened, nearly healed surface. The cornea was opaque and depressed. The exudate from the mucosa of the mouth had sloughed, leaving a healed surface.

The fowl was chloroformed for further examination. It was much emaciated. The internal organs appeared to be normal. Tubes of bouillon inoculated from the liver, spleen, and blood remained clear.

II.

A review of the disease found in the 18 fowls shows that while there are many dissimilarities in the lesions in the different fowls they can not be easily construed to represent different diseases. Although much of the confusion which characterizes the popular conception of "roup" is apparent in the fragmentary history obtained of the outbreaks, a more careful study of the individual cases will show that there is a striking similarity between them. The lesions in the fowls examined were for the greater part localized on the mucosa of the organs in the head. Although all of the fowls which died were much emaciated, there were, with few exceptions, no lesions or evidence of organic disease in the internal organs. The cause of death and the extreme emaciation is difficult to explain in those cases where the lesions were confined to one eye or to the mucosa of the nares, excepting on the supposition that some poisonous or toxic substance was absorbed from the seat of the disease. In those cases where the lesions were in both eyes, or in the mouth and throat, difficulty in finding or swallowing food affords a rational explanation.

A study of the lesions revealed the interesting fact that in some cases the exudate was of a croupous character, and in others of a diphtheritic nature. In a considerable number of the fowls the exudate was more or less sloughed from the underlying tissue. The hypothesis is suggested by these varied conditions that perhaps the apparent croupous exudate is the first stage of the diphtheritic condition, and that the sloughed mass of decomposing exudate so frequently found is the last or advanced stage. There is a certain amount of evidence to support such an hypothesis, both in the description of fowl diphtheria in Europe and in the cases here recorded. The three stages or varieties of lesions which represent the types of this disease as encountered in these investigations may be more definitely defined as follows:.

(1) An exudate of a serous or muco-purulent character in the conjunctiva or nasal cavities. Ordinarily this condition can not be recognized in the mouth. The mucosa in these cases is apparently but slightly altered. (Fowls Nos. 3, 4, 5, Outbreak I, and No. 71, Outbreak III.)

(2) The mucosa over a small or larger area is covered with a spreading exudate of a grayish or yellow color. It is firmly attached to the

mucous membrane, and when removed leaves a raw, bleeding surface. Sections through this exudate and the subjacent tissues show that the epithelial layer is destroyed, and the underlying tissue infiltrated with cells. The extent of the infiltration varies in different individuals. (Fowl 59, Outbreak I.)

(3) The mucosa is covered with a thick mass of exudate, varying in color from a milky white to a lemon yellow or brown. It is easily removed, leaving a more or less granular and healed surface. This sloughed mass is frequently dried at its margins to the adjacent tissue. It emits a strong putrid odor, due to decomposition. The drying of the margins prevents the fowl from expelling the exudate after it becomes separated from the underlying tissue. (Fowl 63, Outbreak V.)

The evidence to support the supposition that the three forms or types of exudate described are different stages in the same morbid process, as gathered from the post-mortem notes and bacteriological study of the cases here reported, may be summarized as follows:

(*a*) Abnormal conditions, representing the intermediate and connecting links between the specific types of lesions, were frequently encountered.

(*b*) Although but one form of exudate was usually present in a single fowl, there were marked exceptions, in which two, and in one case the three, forms were coincident. Thus in fowl No. 75 (Outbreak III) the eye was covered with a sloughed exudate. In the posterior nares there was a layer of muco-purulent substance, and on the mucosa of the mouth were areas of a diphtheritic exudate. Fowls Nos. 69 and 73 furnish examples where the diphtheritic process and the sloughed exudates were present.

(*c*) The same species of a pathogenic bacillus was associated with each form of exudate. It was almost invariably found with the first and second, but rarely with the third.

In the fowls which died, the exudates were for the greater part in the advanced stage, although there were several fatal cases in which the lesions were restricted to an abnormal quantity of a serous or muco-purulent, more or less viscid, exudate in the conjunctiva or nasal cavities. The best illustration of the diphtheritic process was found in certain of the fowls killed for examination.

The distribution of the lesions shows that the conjunctiva was most frequently affected. The exudate in the nasal cavities was in a few cases undoubtedly the result of the coagulation of the liquid which had passed during the course of the first stage from the conjunctiva through the lachrymal duct into the nares. In certain of the other cases, however, the lesions appeared in the nares only (fowls Nos. 3, 4, and 5). Inadvertently, in these cases no material for sectioning was saved from the mucosa of the nares or conjunctiva. Sections of the exudate, with subjacent tissue from the cornea and the mouth, show that there is a cell infiltration into the mucosa which destroys the epithelial layer and frequently the submucous tissues to a considerable depth. (See Pl. VI.)

The fact should not be overlooked, as pointed out in the post-mortem notes, that the disease in the eye was confined to the conjunctiva and the cornea, the posterior portion remaining apparently normal. Although the lesions were found more frequently in the eye, the number of fowls examined was not large enough to admit of the conclusion that this is generally the case.

From the observations thus far made the provisional theory is entertained that the three forms of the exudate—serous or muco-purulent, diphtheritic, and sloughed mass—represent three stages in the course of the same disease. It is easily understood that fowls examined in the first stage would be said to be affected with a catarrhal condition of the mucosa of the eyes or nares. It is highly probable that in many cases the disease never reaches the second stage (see fowls Nos. 3, 4, 5, and 71), and if these cases alone were examined the diphtheritic condition would not be suspected. It appears, however, that in the majority of cases the disease runs its course, and membranes are formed, slough, and recovery follows. It is further presumable that the disease in question appears sometimes in a virulent and destructive form. I am in possession of statements from poultry raisers which show that there are occasionally epizootics of a disease characterized by exudates in the eyes, nose, or mouth, which runs a rapidly fatal course. It appears that it is such outbreaks which have been reported in Europe as diphtheria, and not the low form of chronic disease which I have encountered.

It is highly probable that there are many affections of fowls resembling somewhat closely the lesions found in the cases examined which are etiologically different. There is much doubt respecting the cause of the apparently sporadic cases of this disease. Whether they differ other than in the degree of virulence of the specific organism from the rapidly fatal disease sometimes reported can not be determined until such epizootics can be thoroughly studied. It is hoped that the investigation of this disease or class of diseases may be continued until the doubtful points concerning their nature and cause are clearly explained, and efficient methods of prevention and treatment are determined.

BACTERIA ASSOCIATED WITH THE LESIONS.

It has already been shown that bacteria were not found in the internal organs or blood of the affected fowls when they were examined before post-mortem changes occurred. It has also been stated that a non-motile, pathogenic bacillus was found associated with the lesions, especially in the first and second stages, in a considerable number of the fowls.

The examination of the exudates for bacteria was attended with many difficulties, owing to the presence of a large number of saprophytes.[1] The method found to be the most trustworthy for the isolation of the pathogenic bacteria was the subcutaneous inoculation of experimental animals with the exudates. If the inoculated animals died, pure cultures of the pathogenic organism were obtained from the blood, liver, or spleen. If they survived, they were subsequently chloroformed and cultures of the parasitic bacteria obtained from the tissue at the point of inoculation.[2] By this process the saprophytes were destroyed in the tissues and only those organisms encountered which were suspected to be of more or less etiological importance.

The success of the animal inoculation over the culture methods in isolating the nonmotile pathogenic bacillus is explained from the fact that it is not vigorous in its growth on culture media and that it was ordinarily crowded out by more vigorously growing saprophytes. It is further presumable that in the older exudates its virulence is gradually lost (see fowls Nos. 1 and 59), so that its presence could not be detected readily by animal inoculation. If rabbits had been inoculated, however, with large quantities of the exudate from the more advanced disease a few additional cases containing the pathogenic—but attenuated—bacillus would undoubtedly have been found. The severe local lesions produced in rabbits by the injection of such material caused them, with few exceptions, to be abandoned. It is evident, in view of the results obtained, that rabbits were the most efficient experimental animals to use in this work, and that fowls were the most refractory. The scarcity of rabbits, however, led to the use of other animals in a few cases.

Cover-glass preparations made from the lesions of the affected fowls were carefully stained and examined.[3] Those prepared from the surface of the exudate and from the necrotic masses generally contained innumerable bacteria, but no predominating species was observed. Similar preparations from the base of the exudate in the more recent stages contained a large number of short bacilli with the ends rounded. These forms frequently exhibited a polar stain. Several preparations were stained for tubercle bacilli, but with negative results. A summary of the results obtained from animal inoculations is appended in tabulated form

---

[1] A large number of species of bacteria were isolated and studied somewhat carefully. Among them are several quite interesting forms, some of which were suspected to be of more or less economic importance. Prominent among these was a bacillus which resembled morphologically and in certain of its cultural characters the bacillus of tuberculosis. It was not pathogenic for guinea-pigs or fowls, and did not take the Koch stain.

[2] It is of interest to note that several varieties of colon bacteria were isolated in this way. One of these possessed such variations from the colon bacillus in its cultural manifestations and it was possessed of such marked pathogenesis that for a time it was suspected of bearing some causal relation to the disease. It was briefly described in a footnote on page 43.

[3] In both fresh and stained preparations a long spirillum was found to be quite abundant. It was from 2 to 4 μ in length. Thus far I have been unable to detect it in artificial cultivations.

Animals inoculated with the exudate from affected fowls.

Animals inoculated.	Inoculated with exudate from—	Date of inoculation.	Results.	Remarks.
Rabbit No. 117	Eye, fowl No. 1	Dec. 28, 1893	Died Feb. 10, 1894	Rabbit very much emaciated; no bacteria found in its organs.
White mouse	do	Jan. 23, 1894	Died Jan. 27, 1894	Enlarged and discolored spleen; a pathogenic motile bacillus.
Do	do	do	Died Jan. 29, 1894	Spleen enlarged; nonmotile pathogenic bacillus.
Rabbit No. 144	Nares, fowl No. 3	Feb. 4, 1894	Died Feb. 28, 1894	Septicæmia; nonmotile pathogenic bacillus.
Rabbit No. 145	do	Feb. 24, 1894	Died Feb. 25, 1894	Do.
Rabbit No. 97	Nares, fowl No. 4	do	do	Do.
Rabbit No. 149	Nares, fowl No. 5	Feb. 29, 1894	Died Mar. 1, 1894	Do.
Guinea-pig 222	Mouth, fowl No. 61	Oct. 9, 1894	Chloroformed Oct. 13, 1894.	Local lesion contained *Bacillus coli communis*.
Guinea-pig 223	Nares, fowl No. 62	do	Chloroformed Oct. 15, 1894.	Do.
Guinea-pig 209	Mouth, fowl No. 59	Oct. 20, 1894	Chloroformed Oct. 25, 1894.	Local lesion contained nonmotile pathogenic bacillus.
Fowl No. 50	Eye, fowl No. 65	Oct. 24, 1894	Remained well	No local reaction.
Fowl No. 54	Eye, fowl No. 68	Oct. 27, 1894	do	Do.
Fowl No. 55	do	do	do	Do.
Rabbit No. 215	Eye, fowl No. 69	Nov. 2, 1894	Found dead Nov. 5, 1894.	Pleuritis; hemorrhages in the intestines; nonmotile pathogenic bacillus.
Rabbit No. 223	Eyes, fowl No. 71	Nov. 5, 1894	Found dead Dec. 19, 1894.	Pleuritis and peritonitis; nonmotile pathogenic bacillus.
Rabbit No. 226	Nares, fowl No. 75	Nov. 22, 1894	Found dead Nov. 23, 1894.	Septicæmia; nonmotile pathogenic bacillus.

The table shows that the pathogenic bacillus was obtained from the lesions of fowls Nos. 1, 3, 4, 5, 59, 69, 71, and 75, or nearly 50 per cent of those examined. It is a significant fact that the bacillus was obtained from all the fowls but one (No. 61) where the lesions either in the eye, nares, or mouth were not far advanced. In one case (No. 73) no inoculations were made. The almost constant appearance of this bacillus in the more recent lesions renders the apparent small percentage of cases from which it was isolated of much greater importance than it would at first be considered. A comparative study of the bacteria from the different fowls showed that those obtained from fowls Nos. 1, 59, 69, and 71 were attenuated in varying degrees, while those from the other cases were sufficiently virulent to destroy rabbits within twenty-four hours. This variation in the degree of virulence of the cultures obtained from different fowls is interesting and important. There was no difference in their cultural characters. A glance at the post-mortem notes will show that in the fowls from which the attenuated forms were obtained the lesions were apparently older or more advanced than in the other cases.

In previous investigations[1] rabbits were inoculated with the nasal and pharyngeal secretions of several healthy fowls. These rabbits remained perfectly well. Although septic bacteria are known to be common in the secretions covering the normal mucosa of the upper air passages of several species of domesticated animals, such organisms have not been reported from the mucosa of healthy fowls.

---

[1] Bulletin No. 3, Bureau of Animal Industry, 1893, p. 47.

In 1890 two fowls[1] which died very suddenly at the experiment station of this Bureau were examined. One of them exhibited a croupous exudate extending from the larynx into the trachea, and the other a swollen condition of the mucosa of the mouth and œsophagus. No pathogenic bacteria were obtained from the fowl suffering from the exudate, but from the other were obtained pure cultures of a bacillus not distinguishable from that of swine plague.

It is impossible to positively identify the pathogenic bacillus found associated with the lesions in this disease with the one described by European writers as the cause of fowl diphtheria. Morphologically it is similar to the one described by Loeffler, but its pathogenesis is different. This may be due, however, to difference in the degree of virulence. There is much obscurity in the reference to the properties of the bacilli found by other investigators as the probable cause of diphtheritic affections of fowls and birds, as their descriptions are exceedingly meager, being often limited to the morphology and possibly the character of the growth on one or two of the more commonly used culture media.

In those species of pathogenic bacteria which have been more fully described a more accurate comparison is possible. Thus, the bacilli of fowl cholera, swine plague, and rabbit septicæmia are found to be comparable with the bacillus about to be described, and found in the lesions of this disease of fowls. While it is not my purpose to discuss at this time the identity or relationship of these bacteria, it is important to know that a bacillus associated with the peculiar lesions of this disease should be so similar to the one described by European writers as the cause of fowl cholera. The more essential properties of the bacillus found, apparently the etiological factor, in the lesions of the diphtheritic disease of poultry which I have studied are appended:

DESCRIPTION OF THE NONMOTILE PATHOGENIC BACILLUS.

Morphology.—A nonmotile, rod-shaped organism 0.8 to 1.5 μ long and from 0.8 to 1.2 μ thick. The ends are oval, and the shorter forms appear to be nearly spherical. In bouillon they are frequently in short chains and in clumps. When stained with the aniline dyes in cover-glass preparations made directly from animal tissues they exhibit a light center, occasionally showing deeply stained poles. In preparations from cultures this character is much less marked. No capsule has been positively demonstrated, although certain preparations suggest its existence. It stains readily with the aniline dyes ordinarily used. It does not retain the coloring matter when treated after the Gram method.

Culture characters.—On agar at 36° C. the growth is not vigorous. It is of a neutral gray color, with a glistening, moist-appearing surface. The growth is slightly viscid, and adheres quite firmly to the agar surface. The condensation water becomes faintly clouded. Within agar the colonies appear as minute grayish dots. The growth is completed in about forty-eight hours. In agar plates (double disks) it emits a disagreeable, pungent odor, similar to that observed in cultures of the swine-plague bacillus.

---

[1] Special Report on Swine Plague, Bureau of Animal Industry, Department of Agriculture, 1891, p. 158.

It does not grow in alkaline, peptone gelatin. It does not develop on potato.

Milk remains unchanged in appearance for six weeks. Cultures which had grown for several days were boiled. No change was produced.

Alkaline bouillon at 36° C. becomes uniformly clouded in twenty-four hours. The reaction becomes acid in from one to two days. It does not grow in acid bouillon.

In bouillon containing sugar the growth was slightly more vigorous. In the fermentation tubes the liquid in both branches becomes cloudy. Gas is not produced. In bouillon containing dextrose and saccharose the alkaline reaction is changed to a strongly acid one in twenty-four hours; the bouillon containing lactose remained alkaline.

In a weak solution of peptone containing salt it grew feebly, but gave a decided indol reaction. The phenol reaction was not detected.

Thermal death point.—This organism is destroyed in bouillon cultures heated in a water bath for five minutes at 58° C. An exposure of ten minutes to a temperature of 54° C. was not fatal.

Effect of drying.—The bacillus is destroyed in twenty-four hours by drying on cover-glasses at the temperature of the laboratory.

Effect of low temperature.—Dry cover-glass preparations were exposed in a sterile test tube to a temperature varying from zero to a few degrees above for a period of seventeen hours. At the end of that time they were placed in tubes of bouillon and put in the incubator. These tubes contained pure cultures of this bacillus on the following day.

Disinfectants.—A few preliminary tests showed that this organism was very sensitive to ordinary disinfectants. To determine more accurately the strength of the solution and the time necessary for a fatal exposure, Dr. C. F. Dawson kindly carried out an extensive series of experiments, the more important results of which are appended:

Commercial sulphuric acid in one-eighth of 1 per cent solution destroys in thirty minutes; in one-fourth of 1 per cent it kills in ten minutes.

Lime water destroys the organism in one minute. When diluted four times (0.015 per cent lime) it requires thirty minutes. Carbolic acid in strengths of 0.5, 1, and 2 per cent destroys this bacillus in sixty, five, and one minutes, respectively.

The frequency with which sulphur fumes are used to disinfect chicken houses led to the testing of their efficiency on this organism. The methods and results reported by Dr. Dawson are as follows:

"A drop of bouillon culture was placed upon a sterile cover-glass inside a large glass jar which had been specially prepared for the test. About a half teaspoonful of sulphur was placed upon a sheet of asbestus and ignited. The lid of the jar was put on and in a short time the jar was filled with the white fumes. In *three hours* the cover-glasses were carefully removed and dropped into a tube of sterile bouillon and placed in an incubator. They invariably remained clear."

Pathogenesis.—Rabbits inoculated subcutaneously with 0.1 cc. of the virulent bouillon cultures died in from eighteen to thirty-six hours with lesions similar to those produced by swine-plague bacteria of a virulent type. The organs contained large numbers of oval bacteria exhibiting a polar arrangement of the protoplasm. Those inoculated in a similar manner with the attenuated bacilli lived several days. They exhibited more or less severe local lesions and exudates on one or more of the serous membranes. Adult fowls inoculated subcutaneously with 0.5 cc. of a fresh bouillon culture of the virulent form remained well. A young fowl (about 6 weeks old) inoculated in a similar manner with 0.3 cc. died on the fourth day. The kidneys were abnormally yellow in color and contained large quantities of urates.

Other organs were apparently normal. No bacteria were found in cover-glass preparations from the organs, but tubes inoculated with the blood and liver developed into pure cultures of the bacillus injected.

Several white and gray mice were inoculated subcutaneously with pure cultures. One of the white mice died. The others remained well.

Several efforts were made to produce the local disease by injecting pure cultures of this bacillus into the nasal cavity of fowls. These gave invariably negative results. Cultures were also fed in large quantities to several fowls without producing the disease.

The fact that diphtheritic lesions were not produced in fowls with this bacillus appears to be an argument against its specific relationship to the disease. Loeffler produced the disease in pigeons with the bacillus he isolated. In these investigations the conditions under which the inoculation experiments were made were presumably quite different from those surrounding the fowls which developed the disease. The variations in the degree of virulence of the organism from the different fowls renders it difficult to determine whether the infection depends on the virulence of the bacillus, or a predisposing condition on the part of the fowls. The etiological relation of this bacillus to the disease in question, however, is neither demonstrated nor affirmed, although the evidence in hand is quite enough to warrant the working hypothesis that it is, to a certain extent at least, an exciting agent in the production of the accompanying lesion.

PREVENTION AND TREATMENT.

The nature of this disease, as determined by the foregoing investigations and the published statements of a large number of poultry raisers, indicates that it can be prevented, and if introduced it can be cured. Although it will be necessary to determine experimentally the efficiency of curative agents on a considerable number of fowls before formulas for treatment can be laid down, several important suggestions present themselves at this time, especially in reference to preventive measures.

In order to prevent this disease it is evident that many conditions must be strictly complied with. The character of the food and the general sanitary conditions, including cleanliness, ventilation, and the temperature of the poultry houses, must be considered. Undoubtedly there is much to be learned in connection with the proper care of poultry, especially in rural districts where it is probable that many methods now in use will, after a careful investigation, be found defective. The determination of these details must necessarily be made by those actually engaged in the raising of poultry. In addition to the general sanitary methods, the following rules should be observed:

(1) Fowls which have an exudate on any of the mucous membranes of the head, or which have come from flocks in which such a disease exists or has recently existed, should not be introduced among other poultry.

(2) If the disease appears in one or more fowls of a flock they should be immediately separated from the well ones. If possible, the source of the infection should be determined and removed.

(3) The quite common practice of allowing fowls from different flocks to run together during the day should be discouraged.

(4) Care should be taken to avoid the possibility of bringing the virus of the disease from affected flocks in the dirt or excrement which naturally adheres to the shoes in walking through an infected chicken yard. The same care is necessary in the interchange of working implements, such as shovels, hoes, etc.

It is evident to any careful observer that the fact is too often overlooked that fowls, owing to their method of living, are more liable to infection than other farm animals. This is especially true when they are allowed to run at random, as they too frequently are, picking their living from the garbage pile and barnyards, or securing even more unwholesome food. There is little doubt that many so-called outbreaks of contagious disease among fowls are simply enzootics brought about by improper care. The efficiency of these few suggestions in reference to the prevention of this disease is demonstrated by the success of certain poultry raisers who adhere strictly to the teachings of sanitary methods.

The wide distribution, the large number of fowls affected, and the usual chronic course of this disease render it one of the few poultry affections for which curative measures promise to be of practical value. Although prevention is the safest of cures, when the disease is once introduced as it is in a very large number of flocks, the necessity for remedial treatment is apparent, and where economy is to be considered should be recommended. The practice sometimes followed of destroying all of the affected birds should be discouraged. Although experiments have not been made to test the efficiency of remedies already recommended, or to investigate the practicability of others, the testimony of many practical poultry raisers is, as previously stated, to the effect that the disease is amenable to treatment.

The most certain of the known methods of treatment is the local application of certain disinfectants, among which a weak solution of carbolic acid appears to be the most satisfactory. The fact that the lesions are so much exposed renders the disease especially favorable for topical applications. The administration of mild stimulants has also been recommended. In addition to the medicinal treatment, it is of much importance that the affected fowls be provided with proper food and kept in dry, warm, and well-ventilated apartments. In the course of this study a considerable number of badly affected fowls fully recovered in the animal room of this laboratory with no treatment other than a warm, dry atmosphere.

If the disease has reached its third stage, it is frequently necessary to remove the sloughed exudate, which is retained on account of the attachment of its margins, before the application of the disinfectant. A few fowls have been received where it was evident that death would soon have followed from starvation or a closure of the respiratory passages, and which were immediately relieved and cured by removing the obstructing exudate. There are certain disinfectants and stimulants recommended, which I am advised will give good results, if administered early in the course of the disease, by mixing them with the food and thus eliminating the necessity for individual application.

THE RELATION OF DIPHTHERIA IN FOWLS TO PUBLIC HEALTH.

A comparison of the bacillus of diphtheria in man (Klebs-Loeffler) with the one described by Loeffler as the cause of diphtheria in fowls, shows that morphologically and in their pathogenesis for experimental animals the two organisms are in no way alike. There is also a marked difference in the nature of the exudates in fowls and in man. The non-identity of these diseases has been clearly pointed out by Ménard.[1] Although these diseases are shown by several observations to be unlike in their etiology and the character of their lesions, the transmission of fowl diphtheria to the human species, and vice versa, is affirmed by several writers.

Gerhardt[2] reports 4 cases of diphtheria among 6 workmen who had charge of several thousand fowls, many of which died of diphtheria, in Wesselhausen, Baden. There were no other cases of diphtheria in the neighborhood, and the evidence was quite conclusive that the disease was contracted from the affected fowls. It is also stated that an island on the northeastern coast of Greece had been free from diphtheria for at least a third of a century, when a dozen turkeys, several of which were diseased, were introduced. Soon afterwards diphtheria appeared in a house near the garden where the turkeys were kept. The disease became epidemic on the island causing the death of 36 people, or over 40 per cent of those attacked.

Debrie[3] reports briefly the clinical history of 6 cases of diphtheria which occurred in the garrison of Sebdou, and states that while the sixth case (2 were fatal) was still under treatment in the hospital 10 fowls kept in a house not far from the hospital were attacked with diphtheria, and exhibited symptoms strikingly like those present in the human beings. Five of the 10 fowls died, and two heads were sent to Arloing, who confirmed the diagnosis of fowl diphtheria. The fowls were fed by a hospital attendant, and it was ascertained that an identical outbreak had occurred among the fowls at a neighboring place from which one of the 6 cases of human diphtheria had been brought. Debrie is inclined to the view that human diphtheria is transmissible to fowls and fowl diphtheria to man.

---

[1] Revue d' Hygiene, tome XII (1890), p. 410.

[2] Revue f. Thierheilkunde u. Viehzucht, Bd. VI (1883), p. 180.

[3] Reviewed in Centralblatt f. Bakteriologie, Bd. XIII (1893), p. 730.

Cole[1] reports an interesting case near Jacksonville, Ill. A flock of fowls became affected with a disease characterized by an exudate on the mucosa of the head. Some of the exudates emitted a foul odor.[2] As the weather was cold, one of the chickens was taken into the house where a child about 2½ years old fondled it. Four days later the child was taken sick apparently with diphtheria, from which it died. There were no other cases in the neighborhood, and the affected chicken was the only possible source of infection.

The diphtheritic disease of fowls reported by Loir and Ducloux (loc. cit.) in Tunis, in 1894, spread to the people of that place, resulting in an epidemic of serious proportions. Ménard refers to the fact that men employed to feed young squabs contracted diphtheria by blowing the masticated food into the mouth and crop of squabs suffering with that disease. Schrevens[3] reports several cases of diphtheria in children in which he traces the source of infection to certain poultry.

Although the number of reported cases of the transmission of fowl diphtheria to the human species, and vice versa, is small in comparison with the extent of the disease in poultry, the evidence that such a transmission is possible is quite sufficient to discourage the careless handling of diseased fowls. It is a quite common practice, especially in the rural districts, to bring the sick chickens into the house for treatment, where the children of the household are allowed to fondle them at will. It is not improbable that when this disease is thoroughly investigated the number of cases of direct infection from this source will be found to be much larger than it is at present supposed. Until such investigations are satisfactorily completed the indiscriminate handling of diphtheritic chickens, especially by children, and the exposure of fowls to the infection of diphtheria in the human species, whereby they may become carriers of the virus, should be strenuously avoided.

CONCLUSIONS.

The preceding investigations, though preliminary, are important in bringing together certain existing facts and in a measure correlating certain confusing and contradictory theories in reference to a few of the more common so-called diseases of poultry. Although many important questions, especially concerning the etiology, are as yet unsatisfactorily answered, the facts elicited are of much value as a basis for future investigation. The definite results which have been obtained, and which mark the progress made in our knowledge of fowl pathology, may be summarized in the following determinations:

(1) Many of the so-called diseases of fowls which are characterized

---

[1] Archives of Pediatrics, XI (1894), p. 381.

[2] Cole's description of the disease shows that it was undoubtedly the same as the one I have studied.

[3] Bulletin de l'Acad. Royale de Méd. de Belgique, VIII (1894), p. 380.

by an affection of the mucous membranes of the head, and popularly designated as "roup," diphtheria, influenza, and sometimes cholera, resemble each other so closely in their manifestations that they may be considered as belonging to one and the same disease. This disease is distinct from the rapidly fatal malady which is better known as fowl cholera.

(2) The lesions, as usually encountered, are diphtheritic in nature. In the advanced stages the accumulating exudates decompose and emit a putrid odor. In the earlier stages they are frequently of a serous or muco-purulent character, and not infrequently fowls die before the diphtheritic condition appears.

(3) The same species of a pathogenic bacillus is associated with apparently different forms of lesions, more particularly in the serous or muco-purulent and diphtheritic. This bacillus is not distinguishable from the one described by European writers as the cause of fowl cholera and can not be differentiated in parallel cultures from the bacillus of swine plague. It is comparable in certain respects with the supposed specific organisms of certain diphtheritic diseases of poultry and birds. Its causal relation to this disease, however, is not demonstrated.

(4) This disease usually runs a slow, chronic course from which the majority of the affected fowls recover. Its long duration enables the lesions to be more or less modified from the effect of external contamination. Outbreaks in which the disease runs a rapidly fatal course are reported, but thus far they have not been encountered in the investigations of this Bureau.

(5) This disease, or, as may subsequently be found, diseases, is amenable to treatment. The treatment consists largely in good hygiene, and the removal of the accumulated exudate when the disease has reached the advanced stage. The local application of disinfectants is indicated.

(6) A large number of slight or more severe enzootics among fowls, due to local unsanitary conditions, are popularly considered as outbreaks of some contagious disease.

(7) Judging from the results of these investigations and the recorded experience of certain poultry raisers, it is highly probable that this malady would have been prevented in a large proportion of the flocks in which it now exists if careful sanitary methods had been followed and precautions taken against the introduction of the disease through the purchase of affected fowls.

A STUDY OF A BACILLUS OBTAINED FROM THREE OUTBREAKS OF FOWL CHOLERA.

By VERANUS A. MOORE.

Although a large number of rapidly fatal outbreaks among fowls are reported annually from the central and southern sections of the United States, very little is positively known of the nature and cause of the disease producing them. In 1879–80 Dr. D. E. Salmon[1] investigated certain epizootics among fowls in North Carolina, in which he found a disease comparable to the one described as *cholera des poules* (fowl cholera) in France. With the exception of his investigations, which were made before the development of bacteriological methods now considered essential and which were restricted to an inquiry into the nature of the disease in very few outbreaks, we have no definite knowledge of the disease known as fowl cholera in America. In Europe this disease has been extensively studied and the specific organism carefully described by several observers; the descriptions of the specific bacillus differ somewhat in reference to certain properties, but, without attempting a review of the voluminous literature on the subject, suffice it to say that it is generally accepted that the bacillus of fowl cholera is very closely related to, if not identical with, the bacillus of rabbit septicæmia. The results recorded by Dr. Salmon show that he obtained a similar organism from the fowls he examined, but unfortunately the condition of bacteriological science at that time did not permit the determination of certain important differential biological properties.

The further inquiry into the nature and cause of this disease of fowls has been attended with much delay on account of the difficulty in procuring suitable material. Although this may appear paradoxical in the presence of so many reports of epizootics, a moment's reflection upon the existing condition will reveal its truthfulness. It was shown in the previous article that there is a great looseness in the use of the term "fowl cholera," so that many, if not all, of the forms of local, infectious, and contagious diseases of poultry are frequently designated by it. Again, there is a hesitancy among poultry raisers to report the existence of a disease in their flocks, especially before its seriousness is demonstrated by the death of several individuals when it is usually too late for an investigation. Repeatedly, reported epizootics have been visited by different investigators of this Bureau, but invariably the conditions found precluded the determination of the nature of the disease which had already run its course and disappeared.

---

[1] Reports of the Department of Agriculture, 1880, 1882.

In the summer of 1894 three serious outbreaks of fowl cholera were reported, and from each of them a single fowl was received for examination. From the organs of each of these fowls a nonmotile pathogenic bacillus was obtained in pure cultures. As I was unable to study the outbreaks in the field, the investigations here recorded are necessarily confined to the study of the organism obtained from these fowls and the disease produced by feeding and inoculation experiments. Fowls and rabbits inoculated with pure cultures of the bacillus, isolated from each of the affected fowls, produced similar fatal results, showing that very little if any difference existed in the degree of virulence possessed by the different cultures. A comparative study of their cultural characters and physiological properties showed them to be identical. The study of this organism, however, showed that it possessed certain properties which have not heretofore been attributed to the bacillus of fowl cholera, and which are not possessed by the bacillus of swine plague or rabbit septicæmia, bacteria generally supposed to be identical with it. The history of the outbreaks, so far as learned, and the conditions found in the fowls examined are appended:

I.

April 7, 1894, a dead fowl was received from Mr. S., who resides near the city of Washington, D. C. He had lost nearly all of his fowls (about 50) with cholera during the preceding few weeks, the one brought to us being the last to die. He was requested to notify us if the disease continued in his flock, and to send all the fowls that were subsequently attacked. As no other fowls were received, it is presumable that the disease had disappeared and that the fowl examined was the last to be affected.

The fowl received was a hen about 2 years old. She was in a good condition. The liver, spleen, kidneys, and lungs, appeared to be normal. The crop contained a considerable quantity of dirt, kitchen scraps, corn, and other food. In the abdominal cavity were two large blood clots and a broken egg. The mucosa of the head normal Comb pale.

Cover-glass preparations made from the liver showed no bacteria. Tubes of agar and bouillon were inoculated from the liver and blood. On the following day these contained pure cultures of a nonmotile bacillus. It was fatal to fowls, rabbits, guinea-pigs, and mice.

II.

August 8, 1894, a dead fowl was received by express from Mr. S., of Tackett's Mills, Va. A postal card from him bearing date of August 8, addressed to the Department of Agriculture, reads in part as follows: "I send you by Adams Express a hen with genuine cholera. I have lost about 80 hens and pullets in the last month." * * * About three weeks later a letter was received from Mr. S. in which he stated that he had lost about 100 hens and pullets in the last two months from fowl cholera.

The autopsy of the fowl received showed that death had occurred sometime before its arrival. The organs were somewhat discolored from post-postem changes. The liver was fatty, kidneys yellowish in color, due to an excess of urates in the tubules. Heart muscle pale. The contents of the intestines were greenish and semiliquid in consistency. Mucosa of cloaca had a yellowish color. Tubes of bouillon and agar were inoculated from the liver. The following day the tubes contained pure cultures of a nonmotile bacillus, which upon subsequent study was found to be identical with the bacillus obtained from the fowl examined from the first outbreak.

III.

In August, 1894, while engaged in other investigations, Dr. Theobald Smith had the opportunity of examining a fowl which died in an outbreak of fowl cholera on Block Island, R. I. The fowl died August 13. It was kept on ice until August 15, when it was carefully examined. It came from a flock of about 70 fowls. The disease was reported to have begun in June, and at the time this fowl died only about 14 or 15 were still living. The autopsy notes made by Dr. Smith show that the organs appeared to be normal. Four cultures were made from the spleen, liver, and blood. On the second day following these contained a moderately vigorous growth of a nonmotile bacillus.

August 31: Dr. Smith gave me these cultures for further study. They were found to be identical and pure. A series of inoculations and a careful study of the morphology and physiological properties of this organism showed that it was identical with the bacillus obtained from the other two fowls.

Although the data concerning the nature of the disease in the three outbreaks is exceedingly meager, the facts in hand are quite enough to show that it was practically the same in its manifestations in the three localities. From other sources I have learned that fowl cholera, or a rapidly fatal disease known as such, is not uncommon in the vicinities where two of the outbreaks occurred. No one can doubt that, if the history given is correct, the disease in the flocks from which the fowls came was of a highly contagious, or at least infectious, nature. The presence of the same species of a pathogenic bacillus in the organs of the three fowls is evidence supporting such a conclusion. As the history of the disease in each flock and the examination of the fowls received showed the absence of diphtheritic lesions, it is necessary to consider the disease in question either fowl cholera, in the general acceptation of that term, or to add a new disease to fowl pathology, which, from our limited knowledge of this disease in the United States, does not appear to be justifiable.

DESCRIPTION OF THE BACILLUS.

Morphology.—A nonmotile, rod-shaped organism, varying somewhat in size according to the media in which it develops. In tissues of fowls or rabbits it is from 1.4 to 1.8 μ long and from 1 to 1.3 μ thick. No spores or vacuoles have been discovered. The ends are rounded, so that in the shorter forms it could easily be mistaken for a micrococcus. In the tissues it frequently appears in small clumps. Involution forms are common. In cultures on agar it is more slender than in tissues. When examined in a hanging drop preparation, especially at the edge, it frequently shows a marked polar arrangement of the cellular protoplasm. In these preparations there is observed a marked dancing motion of the organisms. In old bouillon cultures short chains composed of bacilli united end to end are sometimes observed. It stains with the ordinary aniline dyes, but retains the coloring matter very feebly, or not at all, when treated after the Gram method.

Cultural characters.—Agar.—On this medium at 37° C. the growth is moderately vigorous. It has a grayish, glistening appearance. Isolated colonies are from 1 to 2 mm. in diameter, convex, with sharply defined borders. Agar plates emit a peculiar penetrating odor.

Gelatin.—In this medium the growth is less vigorous. In stick cultures it is more abundant along the line of inoculation than on the surface. Isolated colonies are about 0.25 mm. in diameter, appearing as homogeneous bodies to the unaided eye, but slightly granular under low magnification. They have a grayish-yellow color.

Potato.—On the surface of potatoes a delicate grayish-yellow growth appears after about forty-eight hours. Frequently there is no development, owing, presumably, to the acid reaction.

Alkaline boullion.—In twenty-four hours alkaline bouillon becomes uniformly clouded. Reaction acid. The bouillon becomes clear after several days. The growth settles with the formation of a small quantity of friable sediment. The bacteria live for at least four weeks.

Acid bouillon.[1]—Very faintly clouded; acid reaction. Slight sediment, which is not viscid.

Milk.—No change is produced in the appearance of milk for about four weeks. It then begins to change to a clear opalescent-appearing fluid. In about six weeks the milk has a decidedly opalescent appearance. Strongly alkaline in reaction. The addition of a few drops of acetic acid precipitates the casein. A microscopic examination shows that the fat globules are destroyed. This condition is presumably due to the alkali produced by the growth of the bacteria. This appearance of milk is not distinguishable from that produced by the bacillus of hog cholera.

Fermentation of sugars.—Alkaline bouillon containing 1 per cent dextrose in fermentation tubes becomes uniformly cloudy throughout. Strongly acid in reaction. Similar tubes containing saccharose and lactose become clouded throughout, but they remain alkaline in reaction, the degree of alkalinity increasing with age. Gas is not produced during the growth of the bacillus in bouillon containing sugars.

Indol and phenol.—Cultures in a peptone solution give a strong indol reaction when treated after Kitasato's method. No phenol reaction could be obtained when cultures were treated according to Weyl-Lewandowski.

Thermal death point.—Tubes of bouillon inoculated with several drops of a fresh bouillon culture, exposed in a water bath to a temperature of 58° C. for fifteen minutes or longer, did not develop. Those exposed for ten minutes or less developed into pure cultures of the inoculated bacillus. An exposure at 54° C. for thirty minutes produced no deleterious effect.

Effect of disinfectants.—A one per cent solution of carbolic acid was fatal in five minutes. A one-fourth of one per cent solution of commercial sulphuric acid destroyed life in ten minutes. Lime water was fatal in ten minutes, and a solution composed of one part lime water and three parts distilled water was equally as effective in one hour. Sulphur fumes were also fatal in the test applied by Dr. C. F. Dawson. A drop of a bouillon culture was placed upon a sterile cover-glass inside a large glass jar which had been specially prepared for the test. About a half teaspoonful of sulphur was placed upon a sheet of asbestus and ignited. The lid of the jar was put on and in a short time the jar was filled with white fumes. In three hours time the cover-glasses were carefully removed and dropped into tubes of sterile bouillon. These tubes were placed in an incubator. They invariably remained clear.

---

[1] Bouillon prepared from beef without neutralizing or rendering alkaline by a solution of soda or potash.

Effect of low temperature.—Bacteria dried on cover-glasses were placed in sterile test tubes and exposed in a temperature of from zero to a few degrees above for seventeen hours. This exposure did not appreciably retard their subsequent multiplication in bouillon.

The effect of drying.—This bacillus withstood drying at the ordinary temperature on cover-glasses for seven days.

THE NATURE OF THE INOCULATION DISEASE.

The disease produced in the experimental animals with pure cultures of this bacillus is, when compared with the described effect of the bacillus of fowl cholera, exceedingly interesting.

Fowls inoculated in the wing vein with 0.3 cc. of a fresh bouillon culture died in from three to eight days, usually on the fifth or sixth day. The temperature begins to rise on the second day after inoculation. It reaches 109° to 111° F.[1] the day before death occurs. In cases where the fowls live from five to six days they appear perfectly well for at least three days, when the feathers begin to have a slightly ruffled appearance. The exposed portion of the head usually, but not invariably, becomes pale. Toward the last they sit in a crouched position, with the head drawn close to the body. They refuse food, but usually take more or less water. There is sometimes a slight diarrhea. That portion of the excrement secreted by the kidneys becomes yellow.

The changes observed at post-mortem are not conspicuous. The liver is moderately enlarged, soft and fatty. The spleen is occasionally enlarged. The kidneys are marked with yellowish lines, due to the injection of the tubules with urates. The intestinal mucosa is sometimes hyperæmic and sprinkled with punctiform hemorrhages, especially in the rectum. The contents of the intestines are, as a rule, greenish in color and normal in consistency. The mucosa of the cloaca is frequently of a yellowish color, due to urates. The heart muscle is pale. In a few cases, where the fowls resisted for an unusually long period, tubercle-like nodules were observed in the heart and lungs.

The most marked pathological changes were found to occur in the blood. Within twenty four to forty-eight hours after an inoculation into the veins a diminution in the number of the red corpuscles and an increase in the number of leucocytes was determined. This decrease in the number of the red cells and the increase in the white ones continued until death occurred. This is illustrated by the notes from a somewhat typical case.

Fowl No. 82.

[Inoculated February 6.]

Date.	Temperature. F.°	Number of red corpuscles.	Number of white corpuscles.	Remarks.
February 6	107.4	3, 744, 444	22, 222	
February 7	109	8, 417, 391	26, 087	Apparently well.
February 8	108.2	2, 784, 700	55, 000	Do.
February 9	108.4	2, 807, 692	76, 925	Do.
February 11	107.4	3, 481,818	90, 909	Feathers ruffled; refuses food.
February 13	110.2	2, 133, 333	100, 000	Very quiet; comb pale.
February 14	108	2, 530, 000	140. 000	Fowl dies later in the day.

Unfortunately the changes produced in the blood of fowls by bacterial diseases are so little known that the extent to which this marked change in the blood is characteristic of this disease can not be determined until further investigations with other pathogenic bacteria are made.

---

[1] The normal temperature of fowls, as determined by taking the temperature of the fowls used before inoculation, varies considerably, ranging from 104° to 108° F.

The method of destruction of the red corpuscles is not as yet satisfactorily explained. In his report on fowl cholera Dr. Salmon (loc. cit.) illustrated leucocytes surrounding the red corpuscles, but the marked diminution of the red cells was not determined, although he speaks of the pale color of the blood. In a few preparations of fresh blood I have observed similar phenomenon, and also have seen portions of red cells within the granular leucocytes. The determination of the extent of this mode of destruction of the red corpuscles, however, necessitates further investigation. It is of interest to call attention to certain other observations in connection with their destruction.

In carefully heated cover-glass preparations of healthy fowl's blood stained with eosin and methylene blue the nuclei are colored a deep blue, and the cellular protoplasm surrounding the nucleus is stained with the eosin. In similar preparations made from the blood of the affected fowls there are a greater or less number of corpuscles which do not take the eosin stain. In these the portion of the corpuscle surrounding the nucleus remains unstained or becomes slightly tinted with the blue. It occasionally contains one or more vacuoles, and the margin is frequently broken. In some instances a considerable portion of the corpuscle has disappeared. There are a few free nuclei.

Fowls fed with pure cultures and with the viscera of birds dying of this disease usually succumb in from eight to fifteen days. The subcutaneous inoculation with moderate quantities of pure cultures gave negative results.

The organs and the blood of fowls dying from the inoculation disease contained comparatively few bacteria. This was shown in the cover-glass preparations and also in cultures. Frequently the inclined surface of agar rubbed with a large piece of the liver or spleen, or a clot of blood, contained on the following day isolated colonies. In sections the bacteria were frequently found lying in clumps within the capillaries.

In rabbits the disease resembles very closely that produced by attenuated hog-cholera bacteria, although the fatal dose is much larger than for that organism. Subcutaneous inoculations with 0.1 to 0.2 cc. are rarely fatal. When death follows the lesions are characterized by slight local reactions, necrotic areas in the liver, enlarged and discolored spleen, and an infiltration of cells into the follicles of the vermiform appendix and glands about the ileo-cæcal valve. An intravenous inoculation of 0.2 to 0.3 cc. of a fresh bouillon culture produces death in from two to three days. In these cases the spleen is engorged with blood, the liver swollen, and the intestinal mucosa contains hemorrhagic areas. A larger dose produces death in from eighteen to twenty-four hours. An intravenous injection of a small quantity of culture produces lesions similar to those following the subcutaneous inoculation. Cover-glass preparations from the liver, spleen, and blood made soon after death show few elongated bacteria. If a rabbit is allowed to lie for twenty-four hours after death cover-glass preparations show innumerable oval bacteria, which usually exhibit a polar stain.

A guinea-pig inoculated in the abdominal cavity with 0.2 cc. of a bouillon culture died in seven days. The autopsy showed about 50 cc. of a clear, lemon-colored serum in the abdominal cavity. The viscera were covered with a grayish membranous exudate. The pleural cavity contained a large quantity of serum. Lungs collapsed. Subcutaneous inoculations of 0.5 cc. proved fatal in from six to eight days. There was a purulent infiltration into the subcutis about the point of inoculation. Spleen enlarged, dark colored, and friable. Liver pale and usually fatty. No intestinal lesions. Comparatively few bacteria in the organs as shown in cover-glass preparations.

White and gray mice inoculated subcutaneously with 1 to 2 drops of bouillon culture died in from three to five days. The only pronounced macroscopic lesion observed was an enlarged and discolored spleen. Mice inoculated similarly with a much smaller quantity (a single small loop of culture) remained well.

It was thought that perhaps the bacillus was attenuated because the fowls were among the last to die in their respective outbreaks. On that account several series of inoculations were made in different animals for the purpose of increasing its virulence, the culture from the fowl in the first outbreak being used. These gave negative results. Several other experiments are now in progress for the purpose of accelerating its pathogenesis. It seems, however, that its virulence is not easily changed by any of the ordinary methods. After nearly a year's preservation in subculture it is as rapidly fatal as when first isolated.

The bacillus here described differs from the description of the bacillus of fowl cholera (rabbit septicæmia or swine plague) in the following particulars:

(1) Morphology.
(2) Its effect upon milk.
(3) Its effect upon sugars.
(4) Its degree of virulence for rabbits and fowls.
(5) The nature of the inoculation disease, especially in rabbits.

The morphological changes consist in a slight increase in size and the feebleness with which it takes the polar stain. The fact is interesting, however, that the polar stain is well marked when the bacillus is allowed to multiply in the dead animal body.

The saponification of milk is very marked. This property belongs to the hog-cholera group of bacteria, and it has not occurred in parallel cultures of the swine-plague bacillus or other members of that group, in which it is generally conceded by authorities in bacteriology the fowl-cholera bacillus belongs.

The bacilli of rabbit septicæmia and swine plague produce acids in bouillon containing dextrose and saccharose, while this bacillus changes dextrose only. I have not had an opportunity of studying the bacillus of the European disease, and consequently this variation is assumed on the authority of the statements that these species are identical.

The virulence of this bacillus is much less than that ordinarily recorded for fowl cholera. Dr. Salmon produced fatal results in fowls by the subcutaneous injection of minute quantities of a pure culture, while this organism requires for fatal results an intravenous injection of a much larger amount. In rabbits the dissimilarity is much greater. The bacillus of fowl cholera is said to destroy rabbits with acute septicæmia within twenty-four hours after a subcutaneous inoculation with small quantities of pure culture, but this organism produces a disease characterized by certain definite anatomical changes.

The theory that possibly the variation in the lesions is due to an attenuation of the bacillus or a resistance on the part of the animal does not hold, as the disease produced in rabbits with this organism is different from that obtained with attenuated rabbit-septicæmia bacteria. It has frequently been pointed out in the publications from this laboratory that attenuated rabbit-septicæmia or swine-plague bacteria produce local infiltrations and an inflammation followed by an exudate on one or more of the serous membranes.

Another point of difference, taking the bacillus of fowl cholera to be identical with that of swine plague, is the inability to render rabbits immune to the disease by previous injections of sterilized cultures. A carefully conducted experiment was made in which 10 cc. of sterilized bouillon culture was injected intravenously in repeated small doses in two rabbits. They were subsequently inoculated with a minimum fatal dose of pure culture. They died with the control rabbits. Such negative results are invariably obtained with hog-cholera bacteria, but many experiments with swine-plague bacteria show that such treatment will quite as surely produce a pronounced resistance to that disease[1]

There are, however, certain similarities in the disease produced in fowls with the one studied by Dr. Salmon in his investigations in North Carolina. These are, for the greater part, the rise in temperature, the period of incubation, yellowish color of the urates, paleness of the comb, and the refusal of food. The gross pathological changes are also comparable. The diarrhea was less marked in the disease I have produced.

The study of this organism and its pathogenesis are as yet too incomplete to admit of further comparisons at this time. The fact has been shown that in the inoculation disease there is slight or no diarrhea, and pronounced pathological changes occur in the blood. Should these conditions be found to exist in the disease as it occurs in epizootics it is evident that the term fowl cholera is an unfortunate one. It has further been pointed out that the bacillus obtained from three outbreaks of reported fowl cholera differs materially from the organism generally accepted, and ofttimes described by European investigators as the specific cause of that disease. It is quite possible that there are several varieties of fowl cholera, and that the bacillus here described is the etiological factor of one of these forms. The extent to which this bacillus is distributed in this country as the cause of epizootics among fowls can not be determined until further investigations are made.

---

[1] Bulletin No. 6 of the Bureau of Animal Industry, 1894, p. 65.

ON A PATHOGENIC BACILLUS OF THE HOG-CHOLERA GROUP ASSOCIATED WITH A FATAL DISEASE IN PIGEONS.

By Veranus A. Moore.

HISTORY OF THE DISEASE.

In July, 1894, an investigation was made into the nature of a reported epizootic among pigeons at Vineland, N. J. The disease was found, however, to be restricted to the cotes belonging to Mr. A. H. Hawley, and while it was said to be very destructive, its course was slow, and the heavy loss which it occasioned was due to its continued existence and spread. The only symptom observed was a general emaciation, or "going light," as expressed by pigeon fanciers. He had examined post-mortem a large number of the birds, but the only apparent pathological change noticed, other than the loss of flesh, was an exceedingly pale heart muscle.

In addition to the affection mentioned, a few pigeons had died from a disease known as "megrims," which is characterized by emaciation and a peculiar turning of the head from one side to the other, with occasional paroxysms of flying about, apparently in an aimless manner. The economic importance of this disease, however, was said to be insignificant, and it is considered here in connection with the more serious affection on account of the identity of the bacilli isolated from the diseased pigeons.

At the time of my visit Mr. Hawley had a pigeon in the advanced stage of each of these apparently different diseases, and several others which he said showed beginning symptoms. As these diseases appeared to have followed outbreaks of a rapidly fatal affection which had occurred at variable intervals among his pigeons during the preceding few years, a brief historical sketch of the disease in his cotes is of special interest.

Mr. Hawley stated that be began to raise pigeons early in 1889. At first he kept about 160 pairs. For nearly three years his pigeons remained well. Late in the fall of 1891 he purchased 50 pairs, aged about 10 months, from the Fanciers' Pigeon Club, of Philadelphia. About four weeks later these pigeons began to die from a disease designated by him as cholera. About one-half of the purchased pigeons died. The disease did not spread to the pigeons formerly kept on the place. A second and more destructive outbreak occurred in the spring of 1892. During the summer two other quite severe outbreaks occurred. In August, 1893, he lost 125 birds from the same cause. At this time the disease was unusually rapid in its course, the pigeons being sick for only twelve to fourteen hours. The cotes in which the disease occurred were thoroughly sprayed with kerosene emulsion and the floors were washed with carbolic acid. They were vacated and left unoccupied until the spring of 1894, when 75 pairs of pigeons, selected from the other cotes, were placed in three of the apartments, 25 in each, and 17 pairs were purchased and put in a fourth apartment of the same house. The four apartments were arranged side by side, occupying the entire building. The pigeons remained well for about a month, when cholera broke out in two (first and third) of the apartments. About 15 birds died, when the disease was checked by the use of medicines.

Soon after the first outbreak of so-called cholera, late in 1891, pigeons began to die of the disease under investigation. The number of deaths continued to increase until the profit of the business was consumed and the extermination of the pigeons threatened. A record of the mortality kept during the first few months of 1894 showed that in February 83, in March 36, and in April 66 deaths occurred. In May and June the loss was about the same. In July a much smaller proportional number had died up to the time of the investigation. The prevalence of the disease among young pigeons was noted by Mr. Hawley, although old birds were occasionally affected. All of the affected pigeons were examined.

Pigeon No. 1.—This pigeon was found dead on the morning of July 19. It was about 6 weeks old. There was evidence of a slight diarrhea. It was much emaciated. The mucosa of the eyes, nares, and mouth was normal. The liver had a peculiar greenish color, due, presumably, to post-mortem changes. The kidneys were of a pale yellowish color. Intestinal mucosa normal. The heart muscle was exceedingly pale, fatty. Tubes of agar were inoculated from the liver and blood. These contained on the day following pure cultures of a motile bacillus belonging to the hog-cholera group, as will be shown in its subsequent description.

Pigeon No. 2.—This was an old pigeon. It had been sick for several days. It turned its head continually from one side to the other and walked with difficulty. The left eye was closed and contained a small quantity of mucus. It was killed for examination. Pigeon much emaciated. No lesions were found in thoracic or abdominal organs. In the subarchnoid space over the cerebellum and the posterior lobes of the cerebrum there was a grayish-yellow, friable exudate one-half to 1 mm. in thickness and easily removed. Subjacent brain tissue reddened; otherwise normal in appearance. The dura appeared to be normal. The exudate was composed for the greater part of degenerating cells and bacteria. Tubes of agar were inoculated from the exudate over the brain and from the heart blood. The latter remained clear; the former developed into pure cultures of a bacillus not distinguishable in its biological character from the one obtained from the organs of pigeon No. 1.

All of the suspected pigeons were killed and examined, but in every case the organs appeared to be normal and the culture media inoculated remained clear.

DESCRIPTION OF THE BACILLUS.

Morphology.—An actively motile bacillus, varying in size from 1 to 1.6 μ in length and about 1 μ in width. The size varies appreciably in different media. No spores have been detected. The ends are rounded in cultures, but in tissue they appear to be more pointed. In preparations from tissues it usually appears in pairs, united end to end. Frequently, however, it is observed in clumps. The flagella are easily demonstrated by Loeffler's process. The number of filaments vary, eight being the maximum number observed in a single bacillus. In preparations from tissue it usually exhibits a light center with a uniformly stained periphery. In preparations from cultures it usually shows very little, if any, unstained area. It does not take the Gram stain.

Cultural characters.—*Agar.*—On the inclined surface of this medium after twenty-four hours at 37° C. a grayish, glistening, nonviscid growth appears. When isolated the colonies are convex, 0.5 to 1.5 mm. in diameter. Edges sharply defined. The growth is increased slightly during the next twenty-four hours. In stick cultures there is a grayish growth along the course of the needle track.

Gelatin.—In this medium the growth is not vigorous. Surface colonies appear as small grayish dots. When magnified they are finely granular in appearance and of a yellowish tint. In older colonies there is a distinct band which is less granular in appearance about the circumference. It is not liquified.

Potato.—It forms on potato a thin, glistening growth, having a faintly yellowish color. When the reaction of the potato is very acid no growth appears.

Alkaline bouillon.—This medium becomes uniformly clouded after twenty-four hours. The reaction is faintly acid, owing to the fermentation of the muscle sugar. After a longer growth a thin, grayish membrane forms over the surface of the liquid and a grayish band frequently appears on the sides of the tube at the surface of the liquid. The reaction becomes strongly alkaline in old cultures. In *acid bouillon* the growth is feeble and the reaction is not appreciably changed.

Milk.—When this medium is faintly acid in the beginning it slowly becomes alkaline. In about three weeks it gradually changes to a clear, opalescent fluid, due, presumably, to the alkali[1] produced by the growth of the bacteria, as the milk at this time is very strongly alkaline. The addition of a few drops of acetic acid precipitates the casein. If the culture is allowed to remain in the thermostat for several weeks the volume of the milk shrinks, due to evaporation, and the remaining part becomes viscid and of a light brownish color.

Alkaline bouillon containing dextrose.—In this medium it produces a marked fermentation of the sugar with the formation of gas. The acid resulting from the fermentation gives the fluid a strong acid reaction. The gas produced (when collected) in the fermentation tube replaced 54.8 per cent of the liquid in the closed branch. The gas contained 35.7 per cent CO_2 (gas absorbed by potassium hydrate) and 64.3 per cent H (explosive gas).

In similar bouillon containing lactose and saccharose the liquid became uniformly clouded throughout both branches of the tube. No gas was formed. The reaction remained alkaline, and after some days the degree of alkalinity, as detected by litmus paper, was much increased.

A marked indol reaction was determined by Kitasato's method.[2]

Thermal death point.—This organism is destroyed in cultures by an exposure of ten minutes to a temperature of 58° C. in a water bath. It resisted drying on cover-glass preparations made from bouillon cultures at the temperature of the room for eight days. Similar tests were not made with preparations made directly from the organs of animals.

---

[1] It was shown in Bulletin No. 3, 1893, p. 43, that the addition of a few drops of a strong solution of caustic potash or soda would produce this appearance in milk.

[2] This consists in cultivating the bacillus at 37° C. in a sterilized solution composed of 1 per cent peptone and 0.5 per cent sodium chloride in distilled water for from one to three days. To these cultures 1 cc. of a 0.02 per cent solution of potassium nitrate, freshly prepared, and about 3 drops of chemically pure sulphuric acid are added; a violet-pink color indicates the presence of indol.

Disinfectants.—The effect of lime and carbolic acid upon this organism shows that a solution of lime weaker than lime water is not effective, and that a 2 per cent solution of carbolic acid requires one hour to destroy life.

Pathogenesis.—*Rabbits* inoculated in the ear vein with 0.3 cc. of bouillon culture died in thirty-six to forty-eight hours. There was a general congestion of the internal organs. The intestinal mucosa was especially reddened in certain areas. A subcutaneous injection of a similar quantity of culture produced death in from four to six days. In these cases there was considerable purulent infiltration into the subcutaneous tissue about the place of inoculation. The liver was sprinkled with necrotic areas and the spleen much enlarged, dark colored, and friable. When a smaller quantity of culture was injected the local lesion was much more severe, and the follicles of the vermiform appendix and also certain of those of Peyer's patches were infiltrated with cells, giving them the appearance of round, whitish dots. *White mice* died in from three to six days after a subcutaneous inoculation with one to three drops of bouillon culture. The only lesion observable was an enlarged and discolored spleen. *Guinea-pigs* died in from five to ten days after subcutaneous inoculations with from 0.1 to 0.2 cc. of a fresh bouillon culture. *Pigeons* resisted a subcutaneous inoculation with a small dose, but a larger quantity (0.2 to 0.5 cc.) injected into the circulation or pectoral muscle produced death in from two to eight days.

Two pigs inoculated with 5 cc. each of a bouillon culture, one subcutaneously and one in the femoral vein, remained apparently well.

The description of this bacillus shows that it undoubtedly belongs to the hog-cholera group of bacteria, although it differs in certain important properties from the specific bacillus ordinarily encountered in destructive outbreaks of hog cholera. As several varieties [1] of the hog-cholera bacillus have already been described, it is important to note the specific variations of the bacillus in question from the virulent form described [2] originally and the one which is generally meant when this organism is mentioned. The differences are as follows:

(1) It is appreciably larger.

(2) In bouillon a delicate membrane appears on the surface of the liquid and in old cultures a deposit is formed on the sides of the tube.

(3) There is a marked indol reaction.

(4) It is less rapidly fatal in small doses for experimental animals, and the lesions produced in rabbits are comparable to those following the inoculation with the more attenuated varieties. The negative results from the pig inoculations are parallel with many similar ones heretofore made with the virulent variety.

---

[1] In Bulletin No. 6 of the Bureau of Animal Industry, 1894, Dr. Theobald Smith has pointed out the difference that exists in the morphology, cultural characters, and pathogenesis of the hog-cholera bacillus as encountered in different outbreaks of that disease. He also found that several bacilli associated with diseases other than hog cholera belong to the same group. These are a bacillus found by himself in a mare after abortion, *Bacillus enteriditis*, and *Bacillus typhi murium*.

[2] Second Annual Report of the Bureau of Animal Industry (1885), p. 212. It was called at that time swine-plague bacterium.

(5) It is slightly more resistant to the action of certain disinfectants. The variations, with one exception, have already been noted in some one or other of the varieties described by Dr. Smith. It is of interest to note that of the seven varieties of hog-cholera bacillus which he has pointed out the indol reaction was markedly present in but one variety (*Bacillus choleræ suis γ*), and that a nonvirulent form. This is of interest, especially as the indol reaction is prominent in the colon group of bacteria. The greater resistance to disinfectants is also interesting.

The discovery of this bacillus in a disease of pigeons is of much interest in the accumulation of data concerning the distribution of this organism and the range of its disease-producing power. The source of infection is somewhat obscure, but the history points very clearly to its introduction with the pigeons purchased in Philadelphia. Accepting that as the source of infection, it is presumable that the acute disease breaking out at variable intervals was due to this organism, which for undetermined reasons became increased in virulence, or on account of certain conditions the pigeons were rendered more susceptible to it. A careful inquiry failed to reveal the existence of outbreaks of hog cholera in Vineland for many years. It was also learned that the disease found among Mr. Hawley's pigeons had not appeared in other cotes in that vicinity.

The conditions under which the affected pigeons were kept and the care exercised in their management seemed to be all that could be desired. The cotes, however, were located in a slight depression, the land surrounding them being appreciably higher, so that drainage is imperfect. The soil is quite sandy, however, and dries quickly after rains.

The fact was elicited in conversation with a number of pigeon raisers in southern New Jersey that a rapidly fatal disease, comparable to the one described by Mr. Hawley, does occasionally occur among pigeons where the source of infection can not be explained. I was unable to find such an outbreak, although one gentleman told me of recently losing 1,500 birds in one of these outbreaks. The results of the investigation at Vineland render a careful study of the so-called pigeon cholera of much interest. It is not improbable that future inquiry will find that these outbreaks are due to bacteria belonging to the hog-cholera group.

The appearance of this bacillus in the brain of the pigeon affected with the so-called "megrims" is of special interest. It was stated by Mr. Hawley that the old birds were affected in this way. This disease is reported by pigeon raisers to be invariably fatal and more or less common, although comparatively few birds are affected. In this case, however, it appears that the disease was etiologically the same as that which caused the large number of deaths among the younger pigeons, the lesions being localized on the brain. This fact renders the further investigation of "megrims" important in order to determine whether the single case here reported is comparable in its etiology to the disease generally The symptoms appear to be characteristic, so that the disease is readily recognized by pigeon fanciers.

The fact that pigeons, which are ordinarily quite refractory to hog-cholera bacteria, should be affected with a disease due apparently to an organism belonging to that group of bacteria is of much importance. Although it has been shown that several varieties of the bacillus described originally from outbreaks of hog cholera are associated with other diseases and in different species of animals, they appear not to have heretofore been encountered as the apparent cause of any disease in pigeons or other birds, with the possible exception of the bacillus described by Loeffler as the cause of pigeon diphtheria.

The importance of the results of this investigation, which was materially restricted by the limited number of examinations possible, is centered in a few determinations in reference to the hog-cholera bacillus.

(1) The discovery of a member of the hog-cholera group of bacteria apparently as the etiological factor in a chronic disease of pigeons.

(2) The appearance in pure culture of a variety of the hog-cholera bacillus from the exudate covering a portion of the brain of a pigeon killed in the last stages of the disease popularly known as "megrims."

(3) The presence of a marked indol reaction in cultures of a decidedly pathogenic bacillus of the hog-cholera group.

(4) The discovery of a variety of the hog-cholera bacillus in which the cultural characters and the physiological property of producing indol tend to assimilate to a marked degree those of closely related saprophytic forms, but which in its pathogenesis for experimental animals falls but little below that of the virulent form originally described. This striking commingling of saprophytic tendencies and highly parasitic powers tends to strengthen the proposed theory that the hog-cholera bacillus is derived from the closely related colon group of bacteria.

DESCRIPTION OF PLATE I.

FIG. 1. Cæca of turkey No. 5 (somewhat reduced). Both are distended and filled with exudate. They are unusually short. (See fig. 2 on Pl. II.)

FIG. 2. Liver of turkey No. 26 (dorsal aspect). Reduced to seven-ninths of original. The circular spots which are seen on the surface are shown in color in fig. 1 on Pl. III. The other surfaces of this liver presented a similar appearance. The liver is considerably larger than in health.

FIG. II

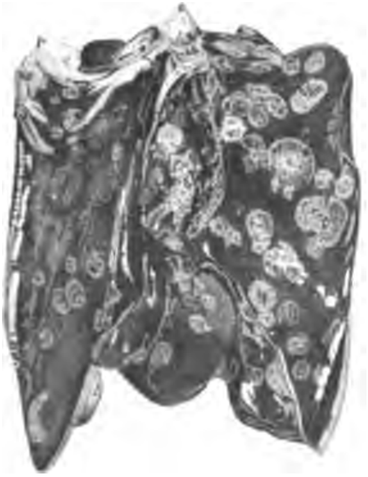
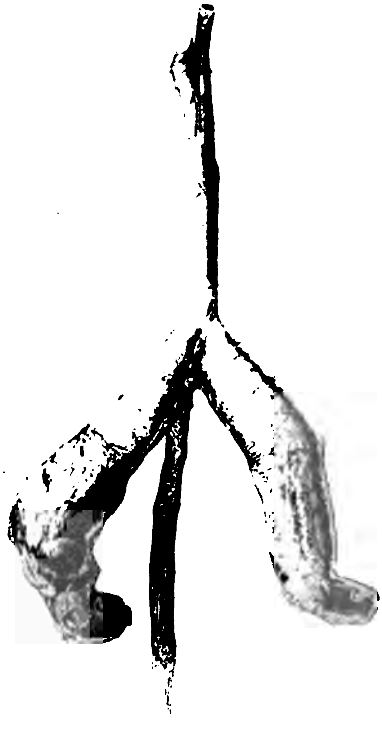


FIG. I



HAINES, DEL.

A. HOEN &

DESCRIPTION OF PLATE II.

FIG. 1. Cæca of a healthy turkey, probably 9 months old. The central tube is the small intestine, the food passing downward in the direction of the arrow. Below, at the junction of the cæca with the intestine, the food is drawn into the cæca by suction.

FIG. 2. One cæcum of turkey No. 5 (see fig. 1, Pl. I), cut open longitudinally. The middle portion of the tube is greatly distended and occluded with an exudate which is firm in consistency. The upper portion contains small stones which have passed down from the gizzard. The irregular thickening of the wall of the tube is shown by a faint line bordering the exudate.

FIG. 3. The other cæcum of No. 5, cut transversely. The great thickening of the wall is shown, together with the presence of a loose plug within the tube, consisting of a firm exudate. Both this and the preceding figure were drawn from the alcoholic preparation. (Natural size.)

FIG. 4. One cæcum of turkey No. 23, slit open and the mucous membrane exposed. The wall of this organ is very much thickened, as may be easily seen by comparing with the healthy tube of a turkey fully six months older (in fig. 1). On the mucous membrane are masses of exudate firmly attached to certain spots of increased thickness. (From an alcoholic preparation.)

FIG. 5. Spots on the liver of turkey No. 34 (natural size). Drawn from an alcoholic preparation.

FIG. IV

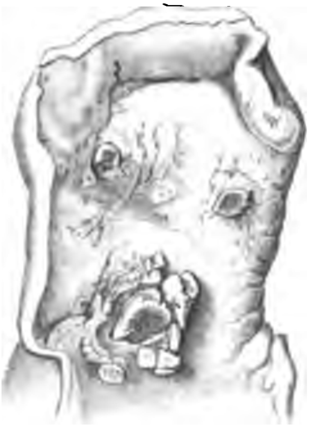


FIG. I

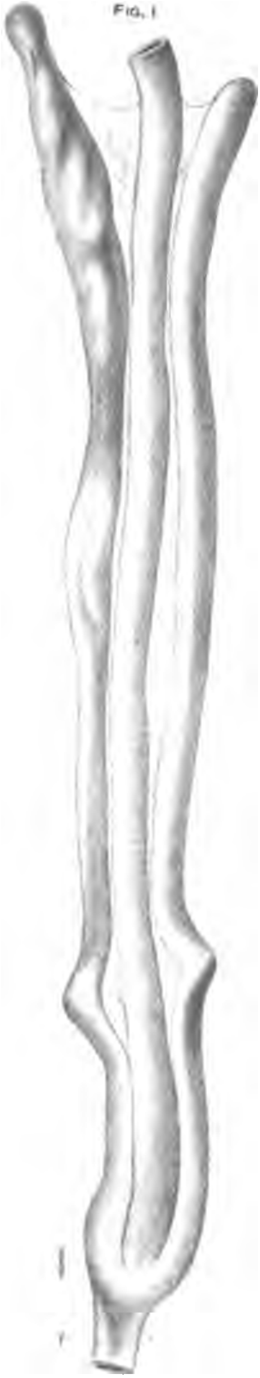


FIG. V

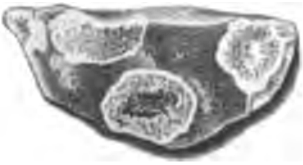


FIG. II

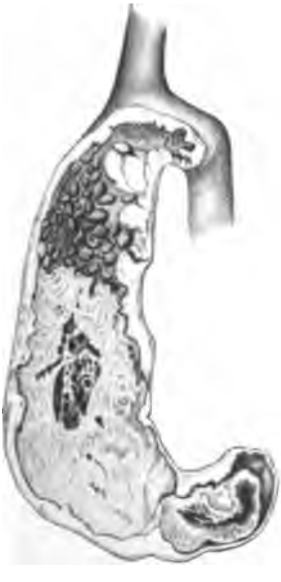
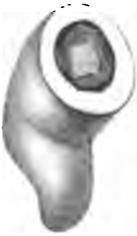


FIG. III



HAINES, DEL.

A. HOEN & CO.

DESCRIPTION OF PLATE III.

FIGS. 1 and 2. Spots on the liver of turkey No. 5. (See photographic reproduction, fig. 2 of Pl. I.) The spots are shown both isolated and confluent. The reticulated structure of these spots is better brought out in the photograph referred to.

FIG. 3. Left lobe of liver of turkey No. 52 (convex surface). The large yellow area in the upper portion of the figure represents a mass of dead tissue penetrating nearly through the entire thickness of the liver. On the right the pale grayish spot represents diseased liver tissue which is undergoing repair. Similarly, the spots in the lower portion of the figure correspond to diseased regions partly healed. Several other spots readily detected in the specimen could not be clearly brought out in the figure. The diffuse change, probably reparative, is shown along the lower margin.

FIG. I

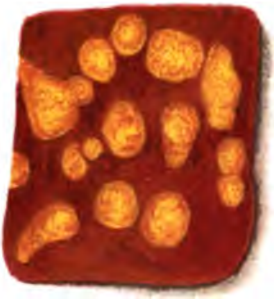


FIG. II

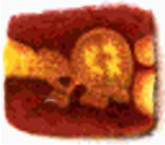
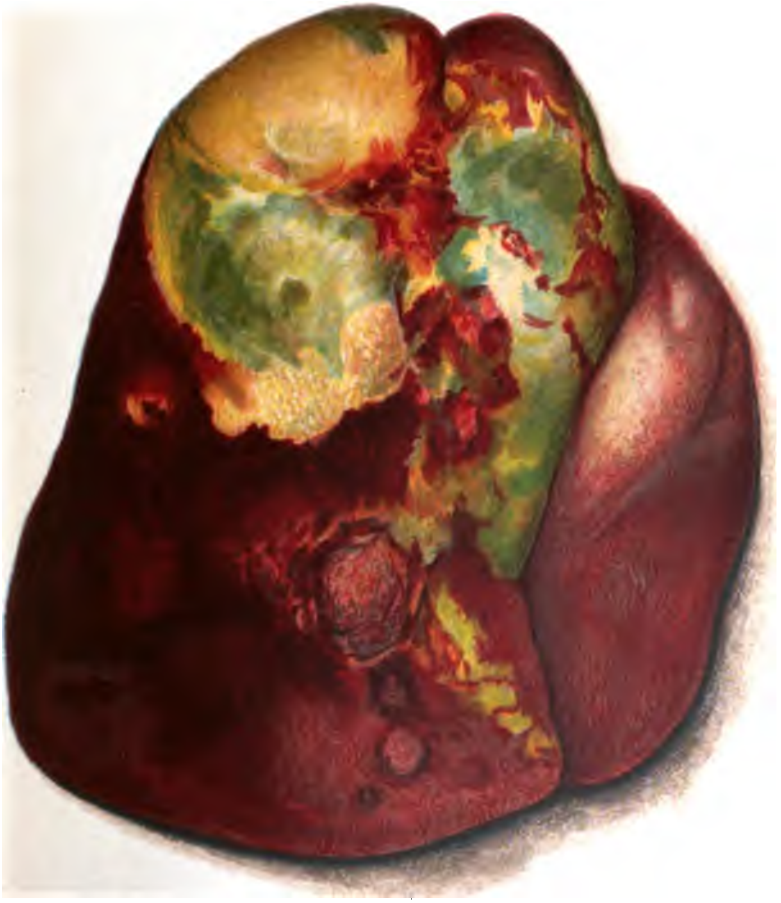


FIG. III



HAINES, DEL. A. HOEN & CO.

DESCRIPTION OF PLATE IV.

FIG. 1 (×500). A portion of the mucous membrane of a cæcum of turkey No. 26, cut transversely. The tissue was hardened in corrosive sublimate and alcohol, cut dry after embedding in paraffin, and stained in Delafield's hematoxylin and in eosin.

(*a*) Nuclei of the epithelium of a crypt or tubule struck nearly tangentially by the section.

(*a*′) Mucin cell represented by a cavity in the section.

(*b*) Spindle-shaped cells belonging to the reticulum of the tissue between the tubules.

(*c*) Protozoa, single and in compact groups, situated within the meshes of the reticulum.

(*d*) Multinucleated (giant) cell which has enveloped some of the protozoa.

FIG. 2 (×500). From the same section.

(*a*) A large group of parasites inclosed in a space of the mucous membrane.

(*a*′) Single parasite.

(*b*) A tissue cell in process of division.

FIG. 3. Section of the liver of turkey No. 34. Hardened in alcohol, cut dry in paraffin, and stained in hematoxylin and in eosin. A large collection of protozoa (*a*) occupying the space formerly occupied by the liver cells. They are probably somewhat forced apart by artificial pressure, for in other sections of the same liver compact masses of protozoa of equal size were not infrequently seen. The parasites are surrounded by capillaries (*b*) dilated and filled with red corpuscles; (*c*) round cells or leucocytes.

FIG. 4 (×500). From the same section as fig. 3. Protoza (*a*) embedded in a granular matrix containing a few nuclei. Some of them largely disintegrated (*b*). (*c*) A capillary filled with red corpuscles. The matrix resembles the protoplasm of the liver cells.

FIG. I

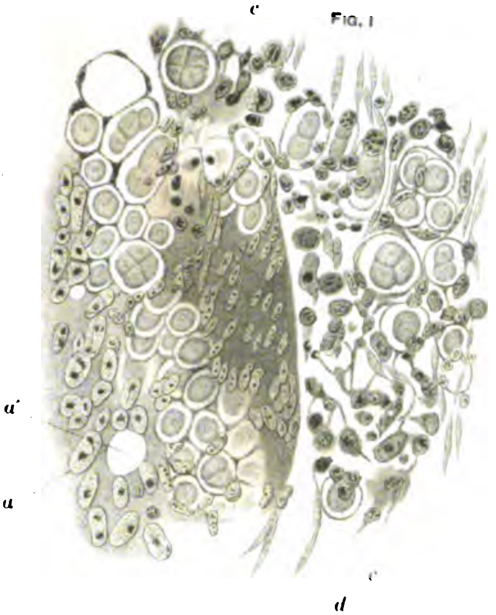


FIG. II

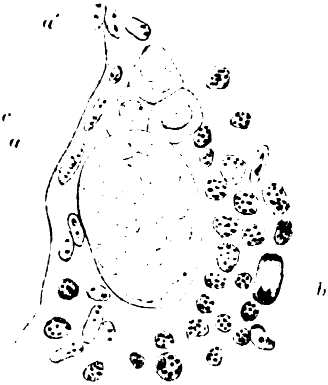


FIG. III

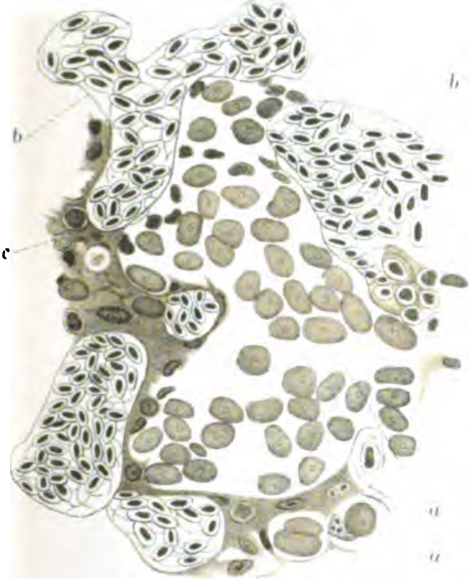
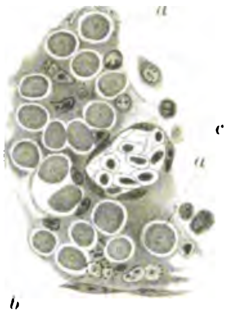


FIG. IV



HAINES, DEL.

A. HOEN & CO.

DESCRIPTION OF PLATE V.

FIG. 1. The protozoan parasites as they appear in crushed and teased fresh tissue (×1,000).

FIG. 2. A parasite with granular body to which a fragment of a giant cell still adheres. The bodies in this fragment are fat globules (×1,000).

FIG. 3. Section through the liver of No. 9. Hardened in alcohol and stained in hematoxylin and eosin (×260). A group of indistinctly demarcated giant cells containing a considerable number of vacuoles which indicate the position of inclosed microparasites. This group of giant cells is situated within what appears to be a thrombosed blood vessel. The coats of the vessel are faintly traceable. The surrounding tissue is involved in coagulation necrosis, presents a homogeneous appearance, and contains scattering nuclei.

FIG. 4 (×500). A giant cell over 80 μ in diameter among a group of ten or more slightly smaller ones found in the wall of cæcum of turkey No. 1. The mucous membrane had ulcerated away, and the greatly thickened remainder (3 to 4 mm. thick) was completely infiltrated with round cells. (*a*) Protozoa, two of them within the cell.

FIG. 5 (×500). Transverse section through a crypt or tubule of the diseased cæcum of turkey No. 26. The lumen of the tubule is packed with minute bodies, probably flagellates. (*a*) Vacuole-like spots representing mucin cells. (*b*) Mitosis.

FIG. 6 (×500). Blood from healthy turkey No. 12, dried as a thin film on a cover-glass and stained, after being fixed at 120° C., in Ehrlich's hematoxylin. (*a*) Red corpuscles, (*b*) leucocytes, (*c*) flagellates, very much broadened in appearance by the drying process.

FIG. 7 (×500). Flagellate as seen in the fresh blood of healthy turkey No. 33.

FIG. I

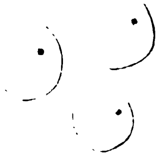


FIG. III

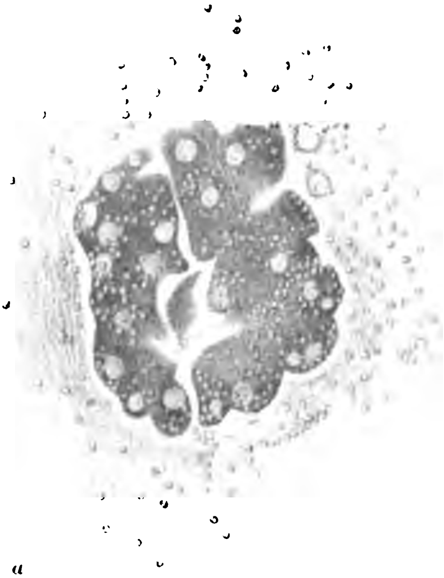


FIG. II

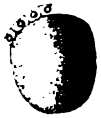


FIG. IV

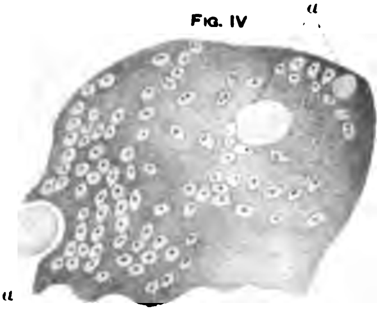


FIG. VII

FIG. V

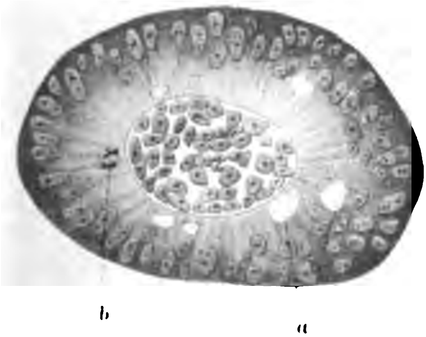
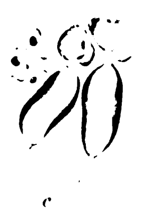


FIG. VI



HAINES, DEL. A. HOEN & CO.

DESCRIPTION OF PLATE VI.

FIG. 1. The roof of the mouth of fowl No. 73, showing the position of the exudate. (Natural size.)

FIG. 2. The floor of the mouth, showing the exudate over the tongue. (Natural size.)

FIG. 3. Section of exudate with subjacent tissues, from mouth of fowl No. 59, showing destruction of the epithelium and cell infiltration of the underlying tissue (×17).

FIG. 4. Sections of the cornea of fowl No. 65 after the removal of the mass of sloughed exudate (×17).

FIG. I

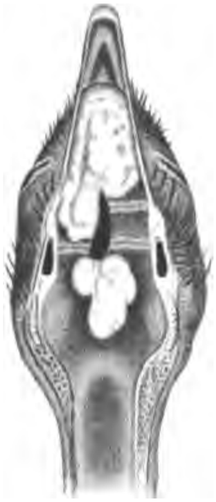


FIG. II

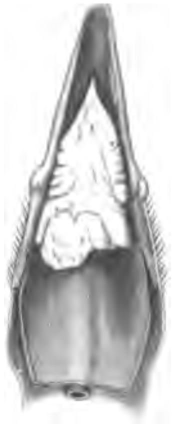


FIG. III

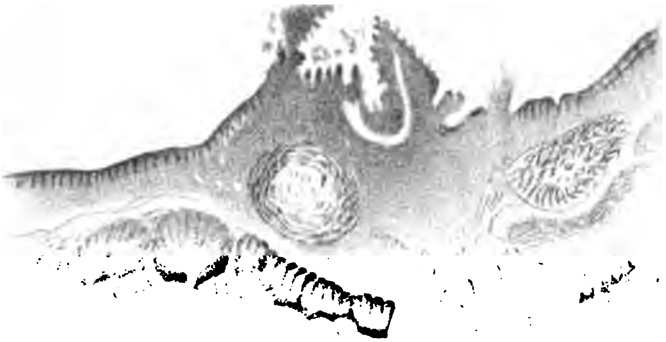


FIG. IV

HAINES, DEL.

A. HOEN &

INDEX.

Page.

- **Amœbic dysentery** 18, 19
- ***Amœba meleagridis***, appearance in giant cells 19
    - tissue 17
    - effect of staining reagents 17
    - fate 19
    - in connective tissue spaces 18
    - is it an intracellular parasite? 19
    - multiplication 19
    - nature 18
    - notes 15
- **Animals, inoculation with exudate of fowls affected with diphtheria** 55
- ***Bacillus coli communis*** 23, 43, 47, 49
    - description of variety 43
    - *enteriditis* 74
    - *typhi murium* 74
- **Blackhead.** (*See* Protozoan disease of turkeys.)
- **Cæca, affections** 9
- **Carbolic acid** 59
- **Chloride of lime** 26
- ***Cholera des poules.*** (*See* Fowl cholera.)
- ***Coccidium oviforme*** 9
    - *tenellum* 9
- **Coops, disinfection** 26
- **Corrosive sublimate** 26
- **Councilman and Lafleur, investigations** 20
- **Cover-glass preparations** 54
- **Cushman, S., assistance** 7
- **Dawson, C. F** 22, 57, 66, 73
- **Diphtheria in fowls** 39
    - conditions favorable 40
    - contagiousness 40
    - economic importance 40
    - epizootics 41
    - lesions 51, 52
    - methods of investigation 41
    - outbreaks investigated 42, 46, 49, 50
    - pathogenic bacillus associated with the lesions 42, 44, 45, 47, 48, 49, 53, 55, 56
    - prevention and treatment 58
    - relation to public health 60
    - saprophytic bacteria associated with 53
    - symptoms 40
- **Disease in pigeons** 71
    - description of bacillus associated with 73
        - relation to *Bacillus choleræ suis* 73
    - economic importance 72
    - history 71
    - symptoms 71
- **Epithelium, destruction** 10

Flagellate 21
Flagg, Professor, assistance 7
Fowl cholera 63
  nature of inoculation disease 67
  outbreaks 64, 65
  pathogenic bacillus obtained from fowls 65
    its relation to rabbit septicæmia and swine-plague bacilli 65, 69
Gallus domesticus 42
Giant cells, appearance of parasites 17
Hawley, A. H., experiments in raising pigeons 71
Kilborne, F. L., examination of fowls 45
Kruse and Pasquale, investigations 20
Leucocytosis 14, 67, 68
Megrims in pigeons 71, 75
Microparasites. (*See* Amœba meleagridis.)
Molluscum contagiosum 18
Nonmotile bacillus in diphtheritic lesions of fowls. (*See* Diphtheria.)
  etiological relation to the disease 58
Mitoses 10
Pathogenic bacillus of the hog-cholera group. (*See* Disease in pigeons.)
Pigeons, diseases, notes 71, 72, 73
Protozoan disease of turkey 7
  analogy to amœbic dysentery 19
  appearance of liver 11
  changes of the liver 12
  extent of cæcal disease 16
    liver disease 16
  external appearance 8
  giant cells 11, 13
  parasites in the liver 13
    multiplication 13
  relation of bacteria 11, 21
    to certain other diseases of poultry 22
      diseases of cæca in fowls 26
      other cæca disease in turkeys 22
  seat of disease 9
  special characters 8
  symptoms 8
  treatment 26
von Ratz, S., investigations 23
Rhode Island Station 7
Roup. (*See* Diphtheria.)
Salmon, D. E., results of investigations 63, 68
Schroeder, E. C., experiments 46
Slaked lime 27
Tæniasis in fowls 46
Toxic substance 51
Traumatism 41
Turkeys, diseases of. (*See* Protozoan disease.)
  examination, history 27
  tapeworms in 8
  voluntary contributions 7
Vineland, N. J., epizootic diseases among pigeons 71
Warts 18
Wheeler, Professor, acknowledgments 7

BULLETIN No. 9.

U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF ANIMAL INDUSTRY.

RULES AND REGULATIONS

GOVERNING THE

OPERATIONS OF THE BUREAU OF ANIMAL INDUSTRY;

ALSO THE

ACTS OF CONGRESS UNDER WHICH THEY ARE MADE.

Dr. D. E. SALMON,
CHIEF OF THE BUREAU OF ANIMAL INDUSTRY.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1895.

LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY,
Washington, D. C., June 25, 1895.

SIR: I transmit herewith a compilation of the rules and regulations governing the operations of the Bureau of Animal Industry, together with the acts of Congress under which they are made, and respectfully recommend the publication of the same as Bulletin No. 9 of this Bureau. The bringing together of this matter in condensed form is a very great convenience not only for permanent preservation, but for the guidance of those engaged in the inspection work of the Bureau, and also for distribution to the constantly increasing number of inquirers for information regarding the work of the Bureau of Animal Industry.

Very respectfully,

D. E. SALMON,
Chief of Bureau.

Hon. J. STERLING MORTON,
Secretary of Agriculture.

CONTENTS.

Page.

Rules and regulations 5

- Order requiring the wearing of a badge while inspecting 5
- Regulations for the inspection of live stock and their products 5
- Order and regulations for the inspection of cattle and sheep for export 13
- Regulations for the safe transport of cattle from the United States to foreign countries 14
- Regulations for the inspection and quarantine of neat cattle, sheep, and other ruminants, and swine imported into the United States 21
- Regulations for cattle transportation 26
- Special order concerning importation of cattle from Mexico 31
- Regulations for the suppression and extirpation of contagious, infectious, and communicable diseases among the domestic animals of the United States 32

Acts of Congress 37

- An act for the establishment of a Bureau of Animal Industry to prevent the exportation of diseased cattle, and to provide means for the suppression and extirpation of pleuro-pneumonia and other contagious diseases among domestic animals 37
- An act providing for an inspection of meats for exportation, prohibiting the importation of adulterated articles of food or drink, and authorizing the President to make proclamation in certain cases, and for other purposes 39
- An act to provide for the safe transport and humane treatment of export cattle from the United States to foreign countries, and for other purposes 42
- An act to provide for the inspection of live cattle, hogs, and the carcasses and products thereof, which are the subjects of interstate commerce, and for other purposes 42
- Paragraphs relating to the Bureau of Animal Industry in the act making appropriations for the Department of Agriculture, etc 43
- Sections of the Revised Statutes referring to the transportation of animals 45

RULES AND REGULATIONS.

ORDER REQUIRING THE WEARING OF A BADGE WHILE INSPECTING.

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SECRETARY,
Washington, D. C., June 21, 1895.

To Employees of the Bureau of Animal Industry:

Hereafter each inspector, assistant inspector, live-stock agent, stock examiner, and tagger shall be required to wear a badge in a conspicuous manner while in the performance of his official duties, and it must not be allowed to leave his possession. Such badge, properly numbered, will be furnished by the Chief of the Bureau of Animal Industry on application through the officer to whom the employee reports.

Each employee furnished with a badge must deposit with the inspector in charge a receipt for the said badge and the sum of $2, which amount must be transmitted by New York draft (without expense to the Department), together with the said receipt, to the Chief of the Bureau of Animal Industry and be duly receipted for by the Disbursing Clerk of the Department, who will be the custodian of this guarantee fund. On return of this receipt and badge by the employee at the expiration of his service the deposit shall be immediately refunded to him.

J. STERLING MORTON,
Secretary.

REGULATIONS FOR THE INSPECTION OF LIVE STOCK AND THEIR PRODUCTS.

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SECRETARY,
Washington, D. C., June 14, 1895.

The following rules and regulations are hereby prescribed for the inspection of live cattle, sheep, hogs, and their carcasses by virtue of the authority conferred upon the Secretary of Agriculture, under the provisions of the act of Congress approved March 3, 1891, entitled "An act to provide for the inspection of live cattle, hogs, and the carcasses and products thereof which are the subjects of interstate commerce, and for other purposes," and amendments thereto approved March 2, 1895, and will supersede all former regulations for the inspection of live stock and their products:

1. Proprietors of slaughterhouses, canning, salting, packing, or rendering establishments, engaged in the slaughter of cattle, sheep, or swine, the carcasses or products of which are to become subjects of interstate or foreign commerce, shall make application to the Secretary of Agriculture for inspection of said animals and their products.

2. The said application must be in writing addressed to the Secretary of Agriculture, Washington, D. C., and shall state the location and address of the slaughterhouse or other establishment, the kind of animals slaughtered, the estimated number of animals slaughtered per week, and the character and quantity of the products to go into interstate or foreign commerce from said establishment; and the said applicant in his application shall agree to conform strictly with all lawful regulations or orders that may be made by the Secretary of Agriculture for carrying on the work of inspection at such establishment.

3. The Secretary of Agriculture will give said establishment an official number by which all its inspected products shall thereafter be known, and this number shall be used both by the inspectors of the Department of Agriculture and by the owners of said establishment to mark the products of the establishment as hereinafter prescribed.

4. The Secretary of Agriculture will designate an inspector to take charge of the examination and inspection of animals and their products for each establishment which has been officially numbered, and will detail to such inspector such assistants or other employees as may be necessary to properly carry on the work of inspection at said establishment. The inspector and all employees under his direction shall have full and free access to all parts of the building or buildings used in the slaughter of animals and the conversion of their carcasses into food products.

(*a*) Each employee engaged in inspection under these regulations will be furnished with a numbered badge, which must be worn in a conspicuous manner while in the performance of his official duties, and which must not be allowed to leave his possession.

(*b*) Each employee furnished with a badge must deposit with the inspector in charge a receipt for the said badge and the sum of $2, which amount must be transmitted by New York draft (without expense to the Department), together with the said receipt, to the Chief of Bureau of Animal Industry and be duly receipted for by the Disbursing Clerk of the Department, who will be the custodian of this guarantee fund. On return of this receipt and badge by the employee at the expiration of his service the deposit shall be immediately refunded to him.

5. An ante-mortem examination of all animals arriving at the stock-yards for slaughter shall be made when they are weighed, or if not

weighed this inspection shall be made in the pens. Any animal found to be diseased or unfit for human food shall be marked by placing in the ear a metal tag bearing "U.S. Condemned" and a serial number. Such condemned animals shall be placed in pens set apart for this purpose and removed only by a numbered permit, signed by the inspector, to an abattoir or rendering works designated by the said inspector, where they shall be killed under the supervision of an employee of the Bureau of Animal Industry and rendered in such manner that their products will be made unfit for human food.

Animals rejected on account of their pregnant or parturient condition must be held in the said pens during gestation and for ten days thereafter, unless removed by permit either for stockers or for rendering in the manner above specified.

6. The inspector in charge of said establishment shall carefully inspect all animals in the pens of said establishment about to be slaughtered, and no animal shall be allowed to pass to the slaughtering room until it has been so inspected. All animals found on either ante-mortem or post-mortem examination to be affected as follows are to be condemned and the carcasses thereof treated as indicated in section 7:

(1) Hog cholera.
(2) Swine plague.
(3) Charbon or anthrax.
(4) Rabies.
(5) Malignant epizootic catarrh.
(6) Pyæmia and septicæmia.
(7) Mange or scab in advanced stages.
(8) Advanced stages of actinomycosis or lumpy-jaw.
(9) Inflammation of the lungs, the intestines, or the peritoneum.
(10) Texas fever.
(11) Extensive or generalized tuberculosis.
(12) Animals in an advanced state of pregnancy or which have recently given birth to young.
(13) Any disease or injury causing elevation of temperature or affecting the system of the animal to a degree which would make the flesh unfit for human food.

Any organ or part of a carcass which is badly bruised or affected by tuberculosis, actinomycosis, cancer, abscess, suppurating sore, or tapeworm cysts must be condemned.

7. The inspector or his assistant shall carefully inspect at the time of slaughter all animals slaughtered at said establishment and make a post-mortem report of the same to the Department. The head of each animal shall be held until the inspection of the carcass is completed in order that it may be identified in case of condemnation of the carcass. Should the carcass of any animal on said post-mortem examination be found to be diseased and unfit for human food, the said carcass shall be marked with the yellow condemnation tag, and the diseased

organ or parts therof, if removed from said carcass, shall be immediately attached to same. The entire carcass shall be at once removed, under the supervision of the inspector or that of some other reliable employee of the Department of Agriculture, to tanks on the premises, and deposited therein, and rendered in such manner as to prevent its withdrawal as a food product. Should the establishment have no facilities for thus destroying the said carcass, it must be removed from the premises by numbered permit from the inspector to rendering works designated by him, and there destroyed under his supervision in such a manner as to make it unsalable as edible meat.

(*a*) Carcasses may be taken to the cooling rooms after marking with the yellow condemnation tag, in cases where only a portion of the carcass is condemned, and when such portion can not be removed without damage to the carcass, until it is properly chilled. After chilling, the condemned portions must be cut out and removed to the tank as provided for whole carcasses. Condemned parts that can be removed without damage to the carcass must be tanked immediately after condemnation.

(*b*) The inspector, or the employee detailed for such purpose, must remove the numbered stub of the condemnation tag at time of placing the carcass or part of carcass in the tanks, and return it to the office of the inspector in charge, with a report as to the number of carcasses or parts of carcasses destroyed, the reason for destruction, and also state that they were tanked in his presence.

(*c*) Should the owners of such condemned carcasses not consent to the foregoing disposition of them, then the inspectors are directed to brand the word "Condemned" upon each side and quarter of said carcasses, and keep a record of the kind and weight of the carcasses, and they shall, under supervision of the inspector, be removed from the packing house where meats are prepared and stored for the interstate and foreign trade; and said firm or corporation shall forward, through the inspector, to the Secretary of Agriculture a sworn statement, monthly, giving in detail the disposition of the carcasses so condemned, and, if the same have been sold, showing to whom, whether for consumption as food or otherwise, with what knowledge, if any, by the purchasers, of their condemnation by this Department, and whether or not before such sale said carcasses have been cooked or their condition at the time of inspection by this Department altered, and, if so, in what way.

The inspectors shall, when authorized by the Secretary of Agriculture, give notice by publication to the express companies and common carriers at the place of condemnation of the fact of condemnation, giving the name of the owner of such carcasses, the time and place of slaughter, the reason for rejection, and a description of the carcasses, and warning them not to transport them out of the State.

8. All persons are warned against removing the tags so attached to condemned carcasses, and are notified that they will be prosecuted

under the acts of Congress of March 3, 1891, and March 2, 1895, for any such attempt to tamper with the device for marking condemned carcasses or parts of carcasses as prescribed by the preceding regulation.

9. Carcasses or parts of carcasses which leave said establishment for interstate or export trade will be tagged by the inspector, or an employee designated by him, with a numbered tag issued by the Department of Agriculture for this purpose, and a record of the same will be sent to the Department at Washington.

(*a*) Carcasses or parts of carcasses which go into the cutting room of an abattoir, and those which are cut up for the local market, or are used for canning purposes, must not be tagged. Those which are to be shipped from one abattoir to another for canning purposes must not be tagged; and the inspector in charge of the abattoir to which the shipment is consigned, in sealed cars, must be notified of the said shipment, including the number and initials of the said cars and the routes traversed by them.

10. Each article of food products made from inspected carcasses must bear a label containing the official number of the establishment from which said product came, and also contain a statement that the same has been inspected under the provisions of the act of March 3, 1891.

(*a*) A copy of said label must be filed at the Department of Agriculture, Washington, D. C., and, after filing, said label will become the mark of identification showing that the products to which it has been attached have been inspected, as provided by these rules and regulations; and any person who shall forge, counterfeit, alter, or deface said label will be prosecuted under the penalty clause of section 4 of the act of March 3, 1891, as amended in the act of March 2, 1895.

(*b*) Each package to be shipped from said establishment to any foreign country must have printed or stenciled on the side or on the top by the packer or exporter the following:

FOR EXPORT.

(*a*) Official number of establishment.
(*b*) Number of pieces or pounds.
(*c*) Trade-mark.

In case said package is for transportation to some other State or Territory, or to the District of Columbia, in place of the words "For export," the words "Interstate trade" shall be substituted.

(*c*) The letters and figures in the above print shall be of the following dimensions: The letters in the words "For export" or the words "Interstate trade" shall not be less than three-fourths of an inch in length, and the other letters and figures not less than one-half inch in length. The letters and figures affixed to said package shall be black and legible, and shall be in such proportion as the inspector of the Department of Agriculture may designate.

11. The inspector of the Department of Agriculture in charge of said establishment, being satisfied that the articles in said packages came from animals inspected by him, and that they are wholesome, sound, and fit for human food, shall paste upon said packages meat inspection stamps bearing serial numbers.

12. In order that the stamps may be protected, and to insure uniformity in affixing, inspectors will require of the proprietors of abattoirs and packing establishments the adoption of cases suitable for one of the two methods mentioned below:

(*a*) The stamp may be affixed in a grooved space let into the box, of sufficient size to admit it, similar to that required by the Internal Revenue Bureau for the stamping of packages of plug tobacco.

(*b*) Stamps may be placed on either end of the package, provided that the sides are made to project at least half an inch to afford the necessary protection from abrasion.

13. The stamp having been affixed it must be immediately canceled. For this purpose the inspector will use a rubber stamp having five parallel waved lines long enough to extend beyond each side of the stamp on the wood of the package. At the top of said rubber stamp shall be the name of the inspector, and at the bottom the abattoir number. The imprinting from this rubber stamp must be with durable ink over and across the stamp, and in such a manner as not to make the reading matter of the stamp illegible. The stamp having been affixed and canceled it must be immediately covered with a coating of transparent varnish or other similar substance. Orders for inspection stamps and for rubber canceling stamps must be made by the inspector on the Chief of the Bureau of Animal Industry.

14. No stamps will be issued by the inspector except to employees of this Department designated by him to supervise the affixing of said stamps to packages of inspected products, and each employee having charge of this work shall be held personally responsible for the stamps issued to him, and shall make an accurate daily report to the inspector of the use of such stamps, and all unused stamps shall be turned over to the custody of the said inspector or of his clerk at the close of each day's work.

(*a*) Proprietors of abattoirs will supply all the necessary help to affix the stamps, which must be done under the supervision of an employee of the inspector in charge.

(*b*) No stamps shall be allowed to remain loose about the office or the abattoirs, and inspectors are instructed to use such additional safeguards as in their judgment will be necessary to properly account for every stamp issued by them, and to have the work of affixing so carefully supervised that nothing but packages of inspected products will be stamped with the meat-inspection stamp of this Department.

(*c*) Any stamps damaged or not used should not appear upon the reports as having been affixed to packages, but should be returned to the Department and a report made as to the reasons for their return.

These regulations will also apply to meat-inspection tags, or seals, and certificates of inspection.

15. Whenever any package of meat products bearing the inspection stamp shall have been opened and its contents removed for sale the stamp on said package must be obliterated.

16. Reports of the work of inspection carried on in every establishment shall be daily forwarded to the Department by the inspector in charge, on such blank forms and in such manner as will be specified by the Department.

17. Whenever an abattoir suspends slaughtering operations the inspector in charge will promptly furlough without pay, until further orders, all employees whose duties are affected by such suspension, notifying this office of the date of closing down. During said suspension he will retain only such employees as are actually necessary to supervise the shipments of inspected products from said abattoir.

SWINE.

18. The inspection of all swine slaughtered in the United States for both interstate and export trade will be similar in all respects to that of cattle and sheep. (See rules 1 to 17.) It must include a careful ante-mortem examination of all hogs, as required by rules 5 and 6, and a subsequent post-mortem examination, as required by rule 7. A microscopic examination for trichinæ must be required for all swine products exported to countries requiring such examination.

(*a*) No microscopic examination will be made of hogs slaughtered for interstate trade, but this examination will be confined to those intended for the export trade, and only at abattoirs which export pork products to countries requiring a certificate from this Government to secure the admission of such meats. All inspectors issuing certificates for export of pork products which have been microscopically examined will enter upon the same the number of each stamp used and imprint the words "Microscopically examined in addition to regular inspection" across the face of the certificate.

(*b*) The carcasses of all hogs that are to enter into interstate trade as dressed pork will be tagged in the same manner as beef is now marked for identification. The products of hog carcasses which enter into interstate trade will be stamped in the same manner as are the products of cattle.

(*c*) The purple meat-inspection stamp will be used only upon packages containing products of hog carcasses which have been microscopically examined for shipment to countries requiring such examination.

19. The microscopic inspection of pork intended for export to countries requiring such inspection shall be conducted as follows:

When the slaughtered hog is passed into the cooling room of said establishment, the inspector in charge, or his assistants, will take from each carcass three samples of muscle, one from the "pillar of the diaphragm," one from the psoas muscle, and the other from the inner aspect of the shoulder, and said samples will be put in a self-locking tin box and a numbered tag will be placed upon the carcass from which said samples have been taken, and a duplicate of said tag will be placed in the box with said samples. The boxes containing the samples from the hogs in the cooling room so tagged will be taken to the microscopist for such establishment, who shall thereupon cause a microscopic examination of the contents of each box containing samples to be made, and shall furnish a written report to the inspector giving the result of said microscopic examination, together with the numbers of all carcasses from which samples have been examined.

20. All carcasses reported by the microscopist to the inspector as affected with trichinæ shall at once be removed from the cooling room or cellar of said establishment under the supervision of said inspector, or that of some other reliable employee of the Department of Agriculture, and shall be disposed of in accordance with the provisions of section 7, or they may be rendered into edible lard at a temperature not less than 150° F., or made into cooked meat products if the temperature is raised to the boiling point a sufficient time to thoroughly cook the interior of the pieces.

21. The inspector in charge of the slaughtering or other establishment will issue a certificate of inspection for all carcasses of animals, or the food products thereof, which are to be exported to foreign countries; which certificate will cite the name of the shipper, the date of inspection, and the name of the consignee and country to which said articles are to be exported. Said certificate will also contain the numbers of the stamps attached to the articles to be exported, and will be issued in serial numbers and in triplicate form. One certificate only will be issued for each consignment. One copy thereof will be delivered to the consignor of such shipment, one copy will be attached to the invoice or shipping bill to accompany the same, and be delivered by the transportation companies to the chief officer of the vessel upon which said consignment is to be transported.

(*a*) All names, marks, stamp numbers, imprints, and other writing of any description made upon the certificate of inspection must be copied on the stub of the book of certificates, and be duly signed by the inspector. This stub constitutes the third copy of the certificate, and shall be preserved and forwarded to this Department.

22. Inspectors are requested to notify the municipal authorities of the character of this inspection and to cooperate with them in preventing the entry of condemned animals or their products into the local market.

J. STERLING MORTON,
Secretary.

ORDER AND REGULATIONS FOR THE INSPECTION OF CATTLE AND SHEEP FOR EXPORT.

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SECRETARY,
Washington, D. C., February 7, 1895.

The following order and regulations are hereby made for the inspection of neat cattle and sheep for export from the United States to Great Britain and Ireland and the Continent of Europe, by virtue of the authority conferred upon me by section 10 of the act of Congress approved August 30, 1890, entitled "An act providing for an inspection of meats for exportation, prohibiting the importation of adulterated articles of food or drink, and authorizing the President to make proclamation in certain cases, and for other purposes:"

1. The Chief of the Bureau of Animal Industry is hereby directed to cause careful veterinary inspection to be made of all neat cattle and sheep to be exported from the United States to Great Britain and Ireland and the Continent of Europe.

2. This inspection will be made at any of the following-named stock yards: Kansas City, Mo.; Chicago, Ill.; Buffalo, N. Y.; Pittsburg, Pa.; and the following ports of export, viz: Portland, Me.; Baltimore, Md.; Boston and Charlestown, Mass.; New York, N. Y.; Philadelphia, Pa., and Norfolk and Newport News, Va. All cattle shipped from any of the aforesaid yards must be tagged before being shipped to the ports of export. Cattle arriving at ports of export from other ports of the United States will be tagged at said ports.

3. After inspection at the aforesaid stock yards all cattle found free from disease and shown not to have been exposed to the contagion of any disease shall be tagged under the direction of the inspector in charge of the yards. After tagging the cattle will be loaded into cleaned and disinfected cars and shipped through from said yards, in said cars, to the port of export.

4. All animals shall be reinspected at the port of export. All railroad companies will be required to furnish clean and disinfected cars for the transportation of cattle and sheep for export, and the various stock yards located at the ports of export shall keep separate, clean, and disinfected yards for the reception of export animals only.

5. Shippers shall notify the inspector in charge of the yards of intended shipments of cattle, and shall give to the said inspector the locality from which said animals have been brought, and the name of the feeder of said animals, and such other information as may be practicable for proper identification of the place from which said animals have come.

6. The inspector, after passing and tagging said cattle, shall notify the inspector in charge of the port of export of the inspection of said animals, giving him the tag numbers and the number and designation of the cars in which said animals are shipped.

7. Export animals, whenever possible, shall be unloaded at the port of export from the cars in which they have been transported directly at the wharves from which they are to be shipped. They shall not be unnecessarily passed over any highway, or removed to cars or boats which are used for conveying other animals. Boats transporting said animals to the ocean steamer must be first cleansed and disinfected under the supervision of the inspector of the port, and the ocean steamer must, before receiving said animals, be thoroughly cleansed or disinfected in accordance with the directions of said inspector. When passage upon or across the public highway is unavoidable in the transportation of animals from the cars to the boat, it must be under such careful supervision and restrictions as the inspector may direct.

8. Any cattle or sheep that are offered for shipment to Great Britain or Ireland or the Continent of Europe, which have not been inspected and transported in accordance with this order and regulations, or which having been inspected are adjudged to be infected, or to have been exposed to infection so as to be dangerous to other animals, shall not be allowed to be placed upon any vessel for exportation.

9. The supervision of the movement of cattle from cars and yards to the ocean steamer at the ports of export will be in charge of the inspector of the port. No ocean steamer will be allowed to receive more cattle or sheep than it can comfortably carry. Overcrowding will not be permitted.

10. The inspector at the port of export will notify the collector of the port of the various shipments of cattle or sheep that are entitled to clearance papers, and certificates of the inspection of said animals will be given to the consignors for transmission with the bills of lading.

J. STERLING MORTON,
Secretary.

REGULATIONS FOR THE SAFE TRANSPORT OF CATTLE FROM THE UNITED STATES TO FOREIGN COUNTRIES.

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SECRETARY,
Washington, D. C., February 18, 1895.

Pursuant to the authority vested in the Secretary of Agriculture by virtue of the act of Congress approved March 3, 1891, entitled "An act to provide for the safe transport and humane treatment of export cattle from the United States to foreign countries, and for other purposes," the following regulations are hereby prescribed for vessels engaged in the transportation of cattle from the United States to foreign countries, and all previous regulations for similar export transportation are hereby rescinded:

1. Upon receipt of information from owners, agents, or master of any vessel desiring to transport cattle from any port in the United States,

the Secretary of Agriculture will direct the inspector in charge of the port from which said vessel is to clear to examine said vessel, and if the same has complied with the regulations hereinafter prescribed a clearance will be authorized by the inspector.

SPACE.

2. Cattle or sheep must not be carried on any part of the vessel where they will interfere with the proper management of the vessel, or with the efficient working of the necessary lifeboats, or with the requisite ventilation of the vessel. Cattle must have 6 feet vertical space on all decks, free of all obstructions.

3. Cattle carried on the upper or spar deck must be allowed a space of 2 feet 6 inches in width by 8 feet in depth per head. Cattle loaded between the decks must be allowed a space of 2 feet 8 inches in width by 8 feet in depth, except in the case of regular cattle ships with satisfactory ventilation, which may fit with an allowance of 2 feet 6 inches in width. No more than 4 head of cattle will be allowed in each pen, except at the end of a row, where 5 may be allowed together. Provided, however, that cattle under 1,000 pounds in weight may be allowed a width of 2 feet 3 inches.

4. Vessels will be allowed to carry three deck loads of cattle, but where it is desired to carry cattle on the lower or steerage deck, it must in all cases be fitted at 2 feet 8 inches by 8 feet per head, and no cattle allowed upon hatches. Special permission for carrying cattle on steerage deck must be obtained from the inspector, which will be granted in cases where said deck is provided with sufficient ventilation, as hereinafter prescribed.

UPPER DECKS.

5. No cattle or sheep shall be allowed on the poop deck or within 20 feet of the breakwater on the spar deck between the 1st of October and the 1st of April. If cattle are carried on the bridge deck proper runways shall be provided for loading and unloading.

(*a*) No cattle shall be carried on the upper decks where the outside rails measure less than 3 feet in height from the deck, nor from October 1 to April 1 upon steamers having free boards which measure less than 5 feet 6 inches vertical space (winter mark).

(*b*) When cattle are carried upon the upper decks strong breakwaters shall be erected at each end and on both sides. Permanent fittings may be constructed either of iron or wood, as hereinafter provided.

UPPER-DECK FITTINGS.

6. ***Stanchions, wooden.***—Stanchions, at least 6 feet 4 inches high, must be of good sound spruce or yellow pine lumber, 4 by 6 inches, placed at proper distances from centers, against the ship's rail and inside stanchions, in their proper place directly in line with outboard stanchions,

to be set up so that the 6-inch way of the stanchions shall set fore and aft. A proper tenon shall be cut on the head of the same to receive the thwart-ship beam; the tenon not to be less than 3 inches in length and the shoulder not less than 2¼ inches on each side of the stanchion, thus leaving the tenon 1½ inches thick. A piece of timber 2 by 3 inches, or 2-inch plank, shall be fastened to the outside of stanchion and run up to underneath rail to chock stanchion down and prevent lifting when beam is sprung to crown of deck. Open-rail ships shall be blocked out on backs of stanchions fair with the outside of rails to receive the outside of planking. Where upper-deck fittings are not permanent the heels of outside stanchions shall be secured by a bracing of 2 by 3 inch sound lumber from the back of each stanchion to sheer streak or waterway, the heels of inside stanchions being properly braced from and to each other. Bulwark stanchions must also be extra stanchioned by raking shores running diagonally from the top of the stanchions to the deck.

(*a*) *Stanchions, iron.*—These may be used in place of wooden stanchions, and shall be not less than 2 inches in diameter, set in iron sockets above and below and fastened with ⅝-inch bolts.

(*b*) *Hook bolts or clamps.*—Hook bolts or clamps must be made of ⅝-inch wrought iron, with hook on outboard end, and thread and nut on inboard end, to pass over and under rail and through outboard stanchion and set up on the inside of same with a nut. These bolts may be double or single. If double then no thread or nut is necessary, but the stanchion will lie shipped through it, thus double hooking the rails. This will be found very useful where funnels or other deck fittings come in the way of beams passing from side to side of ship.

(*c*) *Beams.*—Beams must be of good sound spruce or yellow pine lumber, 3 by 6 inches, to run clear across the ship's beam where practicable. Should any house or deck fittings be in the way, then butt up closely to the same. These beams shall have a 1½ by 4 inch mortise to receive the tenon of each and every stanchion, and to take the same crown as deck of ship by springing down to shoulder of outside stanchions, and to be properly pinned or nailed to tenon and wedged tightly afterwards. The mortises shall be cut not less than 6 inches from outside ends of beams and a piece nailed on outside of same, and trimmed off fair with beam ends to prevent splitting.

(*d*) *Diagonal braces from stanchions to beams.*—Diagonal braces shall be fastened on each stanchion on both sides of same, running up to top side of beam and properly secured by well nailing to both stanchion and beam.

(*e*) *Headboards.*—Headboards shall be not less than 2 by 10, or 3 by 8 inches, of good sound spruce or yellow pine lumber, and secured to every stanchion by ⅝-inch screw bolts passing through same and set up on same with a nut. Where headboards butt on the stanchions a piece of iron ¼ inch thick and 3 inches square shall be placed over the boards like the butt strap. These headboards can be placed on either side of the stanchion. All headboards shall have 1¼-inch holes bored through them at proper distances to tie the animals.

(*f*) *Head pipes.*—In place of wooden headboards, two wrought-iron pipes not less than 2 inches in diameter may be used, placed 8 inches apart. Said head pipes to be made continuous by having a wrought-iron threaded collar securely fastened on the end of each length of pipe into which the next length may be inserted or screwed. Both head pipes to be held in place by means of heavy wrought-iron straps, bolted to each stanchion by four ⅝-inch bolts, the lower head pipe being fitted with movable clamps, holding a ring of suitable size to which cattle may be tied. Said clamps to be set at the proper distance apart in accordance with the regulations and fastened to the pipes with screws.

(*g*) *Footboards.*—Footboards shall be of the same material as headboards, properly nailed or bolted to stanchions on the inside of same.

(*h*) *Division boards.*—Division boards shall be of 2 by 8 inch sound spruce or yellow pine lumber, fitted so as to be removable at any time, and so arranged as to divide the animals into lots of four, thus making compartments for this number all over the vessel. These division boards shall be fitted perpendicularly.

(*i*) *Flooring.*—Where flooring is required it shall be of 1-inch spruce boards, laid fore and aft on ships with wooden decks. Iron-decked ships shall be sheathed with 2-inch spruce or yellow pine, or with 1-inch spruce; but if 1-inch lumber is used, the foot locks shall be 3 by 4 inches, to be laid so that they will properly secure the 1-inch boards, thus preventing them from slipping and at the same time acting as foot locks by showing a surface of 2 by 4 inches to correspond with the 2 by 3 inches. It is optional with the owners whether they permit sheathing to be used on their ships with wooden decks, or whether they allow foot locks to be secured to the deck. But on iron decks it is absolutely necessary (if permanent foot locks are not down) to sheath them before putting down foot locks, in order to fasten same. Cement may be used instead of wood sheathing and foot locks molded in same. If the flooring is raised on any of the decks, it shall be not less than 2 inches thick with scantlings 2 by 3 inches thick, laid athwart ships on the deck, not over 18 inches apart, with 2-inch plank for flooring nailed to them.

(*k*) *Foot locks.*—Foot locks shall be of good sound spruce or yellow pine lumber, or hard wood, size 2 by 3 inches or 3 by 4 inches laid fore and aft, placed 12 inches, 14 inches, 2 feet 2 inches, and 14 inches apart, the first one distant 12 inches from the inside of footboard, filled in athwart ships opposite each stanchion, properly secured to sheathing or deck, and secured by a batten of spruce or yellow pine 2 by 3 inches thick to go over all from stanchion to stanchion. When troughs are used, foot locks will be placed 17, 16, 22, and 16 inches apart.

(*l*) *Outside planking.*—All outside planking on open and closed railed ships must be properly laid fore and aft of ship, and nailed to the backs of stanchions, as close as possible for the cold season, and for the warmer months the top-course planking shall be left off fore and aft of ship, in order to allow a free circulation of air. Nothing less than 2-inch spruce or 1½-inch yellow pine is to be used for this purpose.

(*m*) *Planking of shelter deck to be erected on all exposed decks.*—The planks to form the shelter deck, which must be erected on all exposed decks, shall be laid with 2-inch sound spruce or yellow pine lumber sufficient to cover cattle. These planks shall be laid as closely as possible and well nailed to the beams, thus making a good deck from which to work the ship's gear.

(*n*) *Nails.*—No nails less than 20 penny shall be used in foot locks, or where 2-inch material is used. Twelve-penny nails can be used in 1½-inch plank or under.

UNDER-DECK FITTINGS.

(*o*) *Stanchions.*—Stanchions shall be at least 6 feet 4 inches high and of good sound spruce or yellow pine lumber, 4 by 6 inches, set up at proper distances from centers so that the 6-inch way of same shall stand fore and aft, and jammed in tight between the two decks, properly braced on head and from side to side of ship; this bracing shall be of 2 by 3 inch spruce or yellow pine, and be properly butted against each stanchion. Where it is found impracticable to run these braces across ship, by reason of hatches, etc., coming in the way, they shall be well braced from hatch coamings and from the obstruction which prevents running braces from side to side. The heads of these stanchions shall be braced fore and aft by 2 by 3 inch pieces well nailed on each stanchion and running fore and aft close up to the lower edge of the ship beams, and butted at each end of compartment and against themselves, or chocked in underneath beam and well nailed to heads of stanchions. If upper and lower decks are wood, then the stanchions set up between decks may be secured by well cleating to each deck at heads and heels of same.

(*p*) *Headboards.*—Headboards shall be of the same dimensions and same lumber as those on the upper deck and fastened in the same manner, with 1¼-inch holes bored at right distances to tie animals.

(*q*) *Footboards.*—Footboards shall be of the same dimensions and same lumber as those on the upper deck, and fastened in the same manner.

(*r*) *Division boards.*—Division boards shall be fitted perpendicularly, and arranged so that they divide the animals into pens of four, or at end of row, into pens of five.

(*s*) *Flooring.*—Where ships have decks of wood it shall be optional with owners whether they have boards put down to protect decks or whether they allow the foot locks to be nailed to the ship's deck. (Permanent foot locks may be put down.) If the decks are of iron then wooden flooring must be laid either of 2 inch spruce with 2 by 3 inch foot locks, or of 1-inch spruce with 3 by 4 inch foot locks same as provided for upper decks. Cement may also be used instead of wood flooring, molding the foot locks in their proper places between same.

(*t*) *Foot locks.*—Foot locks may be put down of any hard wood and any size over 2 by 3 inches, but nothing under this size shall be used. They should be laid fore and aft of ship at distances mentioned in upper-deck fittings, and be well fastened to either deck or flooring, or to themselves, and properly filled in athwart ships between stanchions, same as on upper deck.

(*u*) *Troughs.*—Suitable troughs may be formed on the footboards about 12 inches wide, when required, by nailing footboards on outside of stanchion and fitting up on the inside.

(*v*) *Casing for steering gear.*—A suitable casing must be placed over the ship's steering gear when found necessary.

(*w*) *Alleyways.*—Alleyways between the pens must not be less than 18 inches, free of all obstructions. One or more alleyways at least 18 inches wide must be left on each side of decks so that the scuppers can be readily reached and kept clean.

VENTILATION.

7. Each cattle compartment not exceeding 50 feet in length must have at least four bell-mouth ventilators, of not less than 18 inches inside diameter, and with tops exceeding 7 feet in height, two situated at each end of the compartment. Compartments over 50 feet long must have additional ventilators of same dimensions or efficient fans.

8. When it is desired to carry cattle upon the third deck a special permit must be obtained from the inspector of the port. The vessel must be fitted as hereinbefore specified, and properly lighted and ventilated. One set of ventilators should be trimmed to the wind and another set in the opposite direction. They should be tested previous to issuance of permit and should be kept in easy working order.

9. Suitable arrangements shall be made to provide at all times sufficient light for the proper tending of all animals.

10. No cattle shall be loaded along the alleyways by engine room unless the side of said engine room is covered by 1½-inch grooved-and-tongued lumber, making a 3-inch air space.

HATCHES.

11. No cattle shall be loaded upon hatches on decks above cattle, nor upon third-deck hatches when cattle are carried upon such decks, nor shall any merchandise, freight, or food for cattle be loaded upon said hatches, but said hatches shall at all times be kept clear.

(*a*) No cattle shall be loaded upon any hatch where the coamings exceed 18 inches in height, and between-deck hatches shall have not less than 6 feet vertical space between the beams overhead and the hatch coamings under foot for cattle with horns, and 5 feet 6 inches vertical space for cattle without horns.

(*b*) In loading cattle on upper decks four of the largest hatches shall be kept free of cattle—one hatch forward, one aft, and two amidships—so that the intervening spaces will be proportioned as equally as possible. Cattle may be placed upon hatches in excess of this number.

(*c*) Not more than two days' feed for cattle shall be allowed to be carried on deck; this shall be properly covered and shall be the first feed used.

12. All vessels shall carry hogsheads of not less than 400 gallons total capacity for each 100 head of cattle, and these shall be filled with fresh water before sailing and refilled as emptied.

(*a*) Each vessel shall carry water condensers which are in good working order and of sufficient capacity to provide 8 gallons of fresh, cold water each twenty-four hours for each head of cattle.

13. Cattle or sheep suffering from broken limbs or other serious injuries during the voyage shall be slaughtered by the captain of the vessel.

14. The employment of all cattle attendants shall be under the control of owners or agents of steamships, and men so employed shall be reliable and signed as part of the ship's crew, and under the control of the captain of said vessel. They shall be furnished with well-lighted and well-ventilated quarters—as good as the same accommodations furnished for the crew of the ship. An experienced foreman shall be in charge of each shipload of cattle, and not less than one-half of the cattle attendants must be experienced men who have made previous trips with cattle. There shall be one cattle attendant for each 35 head of cattle upon steamers having water pipes extending the entire length of both sides of compartments, and upon steamers not so fitted there shall be one attendant to each 25 head of cattle shipped.

15. Cattle shall be tied with ¾-inch rope, which shall not be used more than once, and must be made from manila or sisal. Any head-ropes returned to the United States shall be immediately seized and destroyed by the inspector of the port.

16. False decks upon which cattle are loaded must be removed and the manure and dirt cleaned from underneath before receiving another load of cattle.

SHEEP.

17. *Attendants.*—There shall be one experienced man in charge of each 150 sheep during the winter months, and one to each 200 sheep during the summer months.

(*a*) *Pens.*—Sheep pens should not exceed 20 feet by 8 feet where two tiers are carried, and each tier shall have a clear vertical space of not less than 3 feet. During the summer months sheep shall not be loaded in tiers between decks, but during the winter months two tiers may be placed in each wing and only one tier amidships.

(*b*) *Flooring stanchions.*—When the pens are built for two tiers of sheep, the flooring between the tiers shall be laid with tongued-and-grooved boards, the stanchions shall be of 4 by 6 inch spruce lumber, and shall be secured to the beams overhead by angle braces similar to cattle fittings.

Outside planking shall be of 2-inch spruce or 1½-inch yellow pine lumber, secured to 4 by 6 inch spruce stanchions, with hook bolts similar to cattle fittings.

(*c*) *Alleyways.*—Athwart-ship alleyways not less than 18 inches wide in the clear shall be left between each pen, and fore-and-aft alleyways in front of each pen, having hayracks and water-tight troughs on three sides. When two tiers of sheep are carried the fore-and-aft alleyways shall be 2 feet wide, clear of all obstructions.

(*d*) *Space.*—The space for each full-grown sheep shall be 4 feet long by 14 inches wide, and for lambs or sheep under 100 pounds weight 4 feet by 12 or 13 inches—2 rows of sheep standing in the 8 feet width of pen.

18. No vessel shall be allowed to take on board any cattle or sheep unless the same have been at the port of embarkation at least twenty-four hours before the vessel sails, except in special cases and by direction of the inspector, nor until the loading of the other cargo has been completed.

19. The inspector may, in case he finds that any of the fittings are worn, decayed, or appear to be unsound, require the same to be replaced before he authorizes the clearance of the vessel. He will also supervise the loading of cattle and see that they are properly stowed and tied, and that all the requirements of these regulations have been complied with.

J. STERLING MORTON,
Secretary.

REGULATIONS FOR THE INSPECTION AND QUARANTINE OF NEAT CATTLE, SHEEP, AND OTHER RUMINANTS, AND SWINE IMPORTED INTO THE UNITED STATES.

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SECRETARY,
Washington, D. C., February 11, 1895.

In pursuance of sections 7, 8, and 10 of the act of Congress entitled "An act providing for the inspection of meats for exportation, and prohibiting the importation of adulterated articles of food or drink, and authorizing the President to make proclamation in certain cases, and for other purposes," approved August 30, 1890, the following regulations are hereby prescribed for the inspection and quarantine of neat cattle, sheep, and other ruminants, and swine imported into the United States, and all previous regulations prescribed for such inspection and quarantine are hereby rescinded:

1. With the approval of the Secretary of the Treasury, the following-named ports are hereby designated as quarantine stations, and all cattle, sheep, and other ruminants, and swine imported into the United States,

must be entered through said ports, viz: On the Atlantic Seaboard, the ports of Boston, New York, and Baltimore; on the Pacific Seaboard, San Diego, Cal.; along the boundary between the United States and Mexico, Nogales, Ariz.; El Paso, Eagle Pass, and Laredo, Tex.; along the border or boundary line between the United States and British Columbia and Canada, through the custom ports of Vanceboro and Houlton, Me.; Richford, Newport, St. Albans, Island Pond, and Beecher Falls, Vt.; Ogdensburg, Rouses Point, Buffalo, Charlotte, and Suspension Bridge, N. Y.; Detroit and Port Huron, Mich.; Minnesota, Minn., and Puget Sound, Wash.

2. The word "animals," when used in these regulations, refers to and includes all or any of the following kinds: Neat cattle, sheep, and other ruminants, and swine. The words "contagious diseases," when used in these regulations, includes and applies to all or any of the following diseases: Anthrax in cattle, sheep, goats, or swine; contagious pleuro-pneumonia in cattle; Texas or splenetic fever in cattle; tuberculosis in cattle; foot-and-mouth disease in cattle, sheep, goats, and swine; rinderpest in cattle and sheep; sheep pox, foot rot, and scab in sheep; hog cholera, swine plague, and erysipelas in swine.

3. All cattle, sheep, and other ruminants imported into the United States from any part of the world shall be accompanied with a certificate from the local authority of the district in which said animals have been for one year next preceding the date of shipment, stating that no contagious pleuro-pneumonia, foot-and-mouth disease, or rinderpest has existed in said district for the past year. And all swine imported into the United States from any part of the world shall be accompanied with a similar certificate relating to the existence of foot-and-mouth disease, hog cholera, and erysipelas. All such animals shall also be accompanied with an affidavit by the owner from whom the importer has purchased them, stating that said animals have been in the district where purchased for one year next preceding the date of sale, and that none of the above-mentioned diseases have existed among them, nor among any animals of the kind with which they have come in contact, for one year last past, and that no inoculation has been practiced among said animals for the past two years. Also by an affidavit from the importer or his agent supervising the shipment, stating that they have not passed through any district infected with contagious diseases affecting said kind of animals; that they have not been exposed in any possible manner to the contagion of any of said contagious diseases, and that the animals, when not driven, have been shipped in clean and disinfected cars and vessels direct from the farm where purchased.

4. The foregoing certificate and affidavits must accompany said animals and be presented to the collector of customs at the port of entry, and by him be delivered to the inspector of the Bureau of Animal Industry stationed at said port, to allow them to be imported into the United States.

5. All neat cattle imported into the United States from any part of the world except Mexico, Central and South America, shall be subject to a quarantine of ninety days, counting from date of arrival at the quarantine station. All sheep and other ruminants, and swine, from any part of the world except North, Central, and South America, shall be subject to a quarantine of fifteen days, counting from date of arrival at the quarantine station.

6. Any person contemplating the importation of animals from any part of the world except North, Central, and South America, or of cattle from the Dominion of Canada, must first obtain from the Secretary of Agriculture two permits, one stating the number and kind of animals to be imported, the port and probable date of shipment, which will entitle them to clearance papers on presentation to the American consul at said port of shipment; the other, stating the port at which said animals are to be landed and quarantined, and the approximate date of their arrival, and this will assure the reception of the number and kind specified therein at the port and quarantine station named, at the date prescribed for their arrival, or at any time during three weeks immediately following, after which the permit will be void. These permits shall in no case be available at any port other than the one mentioned therein. Permits must be in the name of the owner of, or agent for, any one lot of animals. When more persons than one own a lot of animals for which permits have been issued, a release from quarantine will be given each owner for the number and kind he may own, and this release will be a certificate of fulfillment of quarantine regulations. Permits will be issued to quarantine at such ports as the importer may elect, so far as facilities exist at such port, but in no case will permits for importation at any port be granted in excess of the accommodations of the Government quarantine station at such port. United States consuls should give clearance papers or certificates for animals from their districts intended for exportation to the United States only upon presentation of permits as above provided, with dates of probable arrival and destination corresponding with said permits, and in no case for a number in excess of that mentioned therein. When such shipments originate in the interior of a foreign country, these permits should be submitted to the consul of that district and through the forwarding agent to the consul at the port of embarkation.

7. Cattle and sheep from the Dominion of Canada for export from the United States may be entered at the ports of Island Pond and Beecher Falls, Vt., in bond for Portland, Me., for export from the latter port only, provided said animals are accompanied by the health certificate and affidavits required by section 3, and provided, further, that suitable pens are furnished by the railroad companies at the ports of entry for their unloading and proper inspection.

8. All animals imported into the United States shall be carefully inspected by an inspector of the Bureau of Animal Industry, and all

animals found to be free from disease and not to have been exposed to any contagious disease, shall be admitted into the United States, subject to the provisions for quarantine as established in paragraph 5. Whenever any animal is found to be affected with a contagious disease, or to have been exposed to such disease, said animal, and all animals that have been in contact with or exposed to said animal, will be placed in quarantine, and the inspector quarantining the same shall report at once to the Chief of the Bureau of Animal Industry, who will direct whether or not said animals quarantined shall be appraised and slaughtered, as provided by section 8 of the act under which these regulations are made. All animals quarantined by reason of disease or exposure to disease shall not be admitted to the established quarantine grounds, but shall be quarantined elsewhere at the expense of the importer, or be dealt with in such a manner as the Chief of the Bureau of Animal Industry shall determine.

9. In case of imported animals proving to be infected, or to have been exposed to infection, such portions of the cargo or the vessel on which they have arrived as have been exposed to these animals or their emanations shall be subjected, under the direction of the inspector of the Bureau of Animal Industry, to disinfection in such manner as may be considered by said inspector necessary before it can be landed.

10. No litter, fodder, or other aliment, nor any ropes, straps, chains, girths, blankets, poles, buckets, or other things used for or about the animals, and no manure shall be landed, excepting under such regulations as the inspector shall provide.

11. On moving animals from the ocean steamer to the quarantine grounds they shall not be unnecessarily passed over any highways, but must be placed on cars at the wharves or removed to the cars on a boat which is not used for conveying other animals. If such boat has carried animals within three months, it must be first cleaned and then disinfected under the supervision of the inspector, and after the conveyance of the imported animals the boat must be disinfected in the same manner before it may be again used for the conveyance of animals. When passage upon or across the public highway is unavoidable in the transportation of animals from the place of landing to the quarantine grounds, it must be under such careful supervision and restrictions as the inspector may in special cases direct.

12. The banks and chutes used for loading and unloading imported animals shall be reserved for such cattle, or shall be cleansed and disinfected as above before being used for such imported cattle.

13. The railway cars used in the transportation of animals to the quarantine grounds shall be either cars reserved for this exclusive use or box cars not otherwise employed in the transportation of animals or their fresh products, and after each journey with animals to the quarantine grounds they shall be disinfected by thorough cleansing and disinfection under the direction of the inspector.

14. While animals are arriving at the quarantine stations, or leaving them, all quarantined stock in the yards adjoining the alleyways through which they must pass shall be rigidly confined to their sheds. Animals arriving by the same ship may be quarantined together in one yard and shed, but those coming on different ships shall in all cases be placed in separate yards.

15. The gates of all yards of quarantine stations shall be kept locked, except when cattle are entering or leaving quarantine.

16. The attendants on animals in particular yards are forbidden to enter other yards and buildings, unless such are occupied by stock of the same shipment with those under their special care. No dogs, cats, or other animals, except those necessarily present, shall be allowed in the quarantine grounds.

17. The allotment of yards shall be under the direction of the inspector of the port, who shall keep a register of animals entered with description, name of owner, name of vessel in which imported, date of arrival and release, and other important particulars.

18. The inspector shall see that water is regularly furnished to the stock, and the manure removed daily, and that the prescribed rules of the station are enforced.

19. Food and attendance must be provided by the owners of the stock quarantined. Employees of such owners shall keep the sheds and yards clean to the satisfaction of the inspector.

20. Smoking is strictly forbidden within any quarantine inclosure.

21. No visitor shall be admitted to the quarantine station without special written permission from the inspector. Butchers, cattle dealers, and their employees are especially excluded.

22. No public sale shall be allowed within the quarantine grounds.

23. The inspector shall, in his daily rounds, as far as possible, take the temperature of each animal, commencing with the herds that have been longest in quarantine and ending with the most recent arrivals, and shall record such temperatures on lists kept for the purpose. In passing from one herd to another he shall invariably wash his thermometer and hands in a weak solution (1 to 100) of carbolic acid.

24. In case of the appearance of any disease that is diagnosed to be of a contagious nature, the inspector shall notify the Chief of the Bureau of Animal Industry, who shall visit the station personally or send an inspector, and on the confirmation of the diagnosis the herd shall be disposed of according to the gravity of the affection.

25. The yard and shed in which such disease shall have appeared shall be subject to a thorough disinfection. Litter and fodder shall be burned. Sheds, utensils, and other appliances shall be disinfected as the inspector may direct. The yard, fence, and manure box shall be freely sprinkled with a strong solution of chloride of lime. The flooring of the shed shall be lifted and the whole shall be left open to the air and unoccupied for three months.

26. In case of the appearance of any contagious disease the infected herd shall be rigidly confined to its sheds, where disinfectants shall be freely used, and the attendants shall be forbidden all intercourse with the attendants in other yards, and with persons outside the quarantine grounds.

J. Sterling Morton,
Secretary.

[The designation of the ports named in the foregoing regulations as quarantine stations was approved by the Secretary of the Treasury on the 16th day of October, 1890, as provided by section 8 of the act of Congress approved August 30, 1890, providing for inspection of meats and animals.]

REGULATIONS FOR CATTLE TRANSPORTATION.

U. S. Department of Agriculture,
Office of the Secretary,
Washington, D. C., February 5, 1895.

To the Managers and Agents of Railroad and Transportation Companies of the United States, Stockmen, and others:

In accordance with section 7 of the act of Congress approved May 29, 1884, entitled "An act for the establishment of a Bureau of Animal Industry, to prevent the exportation of diseased cattle, and to provide means for the suppression and extirpation of pleuro-pneumonia and other contagious diseases amongst domestic animals," and of the act of Congress approved August 8, 1894, making appropriation for the Department of Agriculture for the fiscal year ending June 30, 1895, you are hereby notified that a contagious and infectious disease known as splenetic or Southern fever exists among cattle in the following-described area:

All that country lying east and south of a line commencing at the extreme western point of the county of Contra Costa, State of California; thence in an easterly direction along the northern boundaries of Contra Costa and San Joaquin counties to the western boundary of Amador County; thence north along the western boundary of Amador County to the southwestern corner of Eldorado County; thence east along the southern boundary of Eldorado County to the boundary line of the State of California; thence southeasterly along the eastern boundary of California to the western boundary of Arizona; thence south along the western boundary of Arizona to the southwestern corner of Arizona; thence easterly along the southern boundaries of Arizona and New Mexico to the Rio Grande River; thence southeasterly along the Rio Grande River to the southwestern corner of the county of Foley, State of Texas, continuing along the Rio Grande River in a northeasterly direction to the southwestern corner of the county of Pecos; thence following the western boundary of Pecos County to the southeast corner of Reeves County; thence following the boundary line between the counties of Pecos and Reeves to the Pecos River; thence southeasterly following the said Pecos River to the northwest corner of Crockett County; thence easterly along the northern boundaries of Crockett and Schleicher counties to the southeastern corner of Irion County; thence northerly along the eastern boundary of Irion County to the northeast corner of said county, thence northerly to the southern boundary of Coke County; thence westerly to the southwestern corner of Coke County; thence northerly along the western boundary of Coke County to the southern boundary of Mitchell County; thence easterly to the southeastern corner of Mitchell County; thence northerly along the western boundary of Nolan County to the northwest corner of Nolan County; thence easterly along the northern boundary of said county to the southwestern corner of Jones County; thence northerly along the western boundary of Jones County to the southern boundary of Stonewall County; thence easterly along the northern boundaries of Jones and Shackelford counties to the southwestern corner of Throckmorton County; thence northerly along the western boundaries of Throckmorton, Baylor, and Wilbarger counties to the Red River; continuing along the Red River in a southeasterly direction to the southeast corner of the county of Greer, Territory of Oklahoma; thence northerly following the course of the North Fork of the Red River to its intersection with the southern boundary line of Roger Mills County; thence easterly along the southern boundary of Roger Mills and Washita counties to the southeastern corner of Washita County; thence northerly along the eastern boundary of Washita County to the northeast corner of said county; continuing in a northerly direction along the eastern boundary of the county of G to the southwestern corner of the county of Blaine; thence easterly along the southern boundary of Blaine County to the southeast corner of said county; thence north on the eastern boundary of said county to the northwest corner of Canadian County; thence east on the northern boundary of said county to the northeast corner of said county; thence north along the eastern boundary of Kingfisher County to the northeastern corner of said county; thence east along the southern boundary of O County to the southeast corner of said county; thence north along the eastern boundary of O County to the northeast corner of said county; thence east along the southern boundary of K County to the west line of the Ponca Indian Reservation; thence north on the west line of said reservation to the northwest corner of said reservation; thence east along the northern boundary of the Ponca Reservation to the Arkansas River; thence in a northerly direction, following the course of said river to its intersection with the thirty-seventh parallel of north latitude at the southern boundary line of Kansas; thence east along the southern boundary of the State of Kansas to the southwest corner of Cherokee

County, State of Kansas; thence northerly along the western boundary of the county of Cherokee to the northwest corner of said county; thence easterly along the northern boundary of said county to the State of Missouri; thence easterly along the northern boundary of the county of Jasper, in the State of Missouri, to the northeast corner of said county; thence southerly along the eastern boundary of the counties of Jasper and Newton, in said State, to the southeast corner of Newton County; thence westwardly along the southern boundary of the county of Newton to the eastern boundary line of Indian Territory; thence southerly along the eastern boundary of the Indian Territory to the southwestern corner of Washington County, State of Arkansas; thence easterly along the southern boundaries of the counties of Washington, Madison, Newton, Searcy, and Stone to the western boundary of Independence County; thence southerly along the western boundary of Independence County to the southwest corner of Independence County; thence easterly along the southern boundary of Independence County to the southeast corner of Independence County; thence northerly along the eastern boundary of said county to the northeast corner of said county; thence easterly along the southern boundary of Lawrence County to the southeast corner of said county; thence northerly along the eastern boundary of said county to the southwestern corner of Greene County; thence easterly along the southern boundary of Greene County to the southern boundary of the State of Missouri, and along said southern boundary of the State of Missouri to the Mississippi River; thence southerly along the Mississippi River to the northwestern corner of the county of Shelby, State of Tennessee; thence along the northern boundary of the county of Shelby to the northeast corner of said county; thence northerly along the western boundary of Fayette County to the northwest corner of Fayette County; thence easterly along the northern boundary of Fayette County to the northeast corner of said county; thence northerly along the western boundary of Hardeman County to the northwest corner of said county; thence easterly along the southern boundary of Haywood County to the southeast corner of said county; thence northerly along the eastern boundary of Haywood County to the northeast corner of said county; thence in a northeastly direction along the western boundary of Madison County to the northwestern corner of said county; thence easterly along the northern boundary of said county to the northeast corner of said county; thence northerly along the western boundary of Henderson County to the northwest corner of said county; thence easterly along the northern boundary of said county to the northeast corner of said county; thence northerly along the western boundary of Decatur County to the northwest corner of said county; thence easterly along the northern boundary of said county to the Tennessee River; thence following the Tennessee River in a southerly direction to the southwest corner of the county of Perry; thence east along the southern boundary of Perry County to the southeast corner of said county; thence easterly along the northern boundary of Wayne County to the northeastern corner of said county; thence southerly along the eastern boundary of Wayne County to the boundary line of the State of Tennessee; thence easterly along the southern boundary of the State of Tennessee to the western boundary of the State of North Carolina; thence along the southern boundaries of the counties of Cherokee, Clay, Macon, Jackson, and Transylvania, State of North Carolina, to the southeast corner of the county of Transylvania; thence northwesterly along the eastern boundary of Transylvania County to the southwest corner of the county of Buncombe; thence in a northeasterly direction following the Blue Ridge Mountains to the southwestern corner of the county of Amherst, State of Virginia; thence southeasterly along the southern boundary of the county of Amherst to the western boundary of the county of Appomattox; thence in a northeasterly direction along the western boundaries of the counties of Appomattox, Buckingham, Fluvanna, and Louisa to the southern boundary of the county of Orange; thence easterly along the southern boundary of the county of Orange to the western boundary of the county of Spottsylvania; thence in a southeasterly direction along the western boundaries of the counties of Spottsylvania and Caroline to the northwestern corner of King William County; thence in a northeasterly direction along the southern boundary of the county of Caroline to the eastern boundary of said county; thence southerly along the eastern boundary of King and Queen County to the southwest corner of Essex County; thence along the southern boundaries of Essex and Richmond counties to the southeast corner of Richmond County; thence northerly along the eastern boundary of said county to the northeast corner of Northumberland County; thence in a northeasterly direction along the northern boundary of said county to the Potomac River; thence following the Potomac River southerly to the Chesapeake Bay; thence easterly along the southern boundary of the State of Maryland to the Atlantic Ocean.

From the 15th day of February to the 1st day of December, 1895, no cattle are to be transported from said area to any portion of the United States north or west of the above-described line, except by rail for immediate slaughter, and when so transported the following regulations must be observed:

1. When any cattle in course of transportation from said area are unloaded north or west of this line to be fed or watered the places where said cattle are to be so fed or watered shall be set apart, and no other cattle shall be admitted thereto.

2. On unloading said cattle at their points of destination pens shall be set apart to receive them, and no other cattle shall be admitted to said pens; and the regulations relating to the movement of Texas cattle, prescribed by the cattle sanitary officers of the State where unloaded, shall be carefully observed. The cars that have carried said stock shall

be cleansed and disinfected before they are again used to transport, store, or shelter animals or merchandise.

3. All cars carrying cattle from said area shall bear placards stating that said cars contain Southern cattle, and each of the waybills of said shipments shall have a note upon its face with a similar statement. Whenever any cattle have come from said area and shall be reshipped from any point at which they have been unloaded to other points of destination, the cars carrying said animals shall bear similar placards with like statements, and the waybills be so stamped. At whatever point these cattle shall be unloaded they shall be placed in separate pens to which no other cattle shall be admitted.

4. The cars used to transport such animals, and the pens in which they are fed and watered, and the pens set apart for their reception at points of destination, shall be disinfected in the following manner:

(*a*) Remove all litter and manure. This litter and manure may be disinfected by mixing it with lime or diluted sulphuric acid, or, if not disinfected, it may be stored where no cattle can come into contact with it until after December 1.

(*b*) Wash the cars and the feeding and watering troughs with water until clean.

(*c*) Saturate the walls and floors of the cars and fencing, troughs, and chutes of the pens with a solution made by dissolving four ounces of chloride of lime to each gallon of water. Or disinfect the cars with a jet of steam under a pressure of not less than 50 pounds to the square inch.

5. It is further expressly provided that cattle which have been in the counties of Wilbarger, Baylor, Throckmorton, Shackelford, Jones, Nolan, Coke, and the northern half of Pecos County, State of Texas, since January 1, 1895, and have not come into contact with any cattle brought into said counties from any other counties in the infected area since that date, may be moved from the said counties by rail into the States of Colorado, Wyoming, Montana, North Dakota, and South Dakota, in accordance with the regulations made by said States for the admission of Southern cattle thereto: Provided—

(*a*) That a permit shall first be obtained from the Secretary of Agriculture for such movement. The application for said permit must state the name of the county in which said cattle are located, the name of the owner of said cattle, the number of cattle to be moved, and the route over which said cattle are to be transported to the above-named States.

(*b*) That said permit shall be forwarded to the inspector of the Department stationed at Kansas City, Mo., who will detail an officer to inspect said cattle and ascertain whether they are entitled to be shipped under the provisions of this order, and who, upon finding that the same are so entitled, will countersign said permit and supervise the movement of said cattle to point of shipment. The said officer before delivering such permit shall obtain affidavits of the owner or manager of the cattle and of two reputable and disinterested persons, showing that they are acquainted with the cattle sought to be shipped, and that they have known said cattle since January 1, 1895, and that said cattle have been kept in the territory described above and have not come into contact with any other Southern cattle. These affidavits will be forwarded by him to the Department of Agriculture.

(*c*) That cattle from said area shall go into said States only for slaughter or grazing, and shall on no account be reshipped from said States into any other State or Territory of the United States before December 1, 1895.

(*d*) That all cars which have carried cattle from said area shall, upon unloading, at once be cleaned and disinfected in the manner provided by these regulations.

(*e*) That the State authorities of the States of Colorado, Wyoming, Montana, North Dakota, and South Dakota agree to enforce these provisions.

The losses which formerly occurred to the owners of susceptible cattle, both in the interstate and export trade, by the contraction of this disease from exposure in unclean and infected cars and pens, and by means of the manure carried in unclean cars from place to place, became a matter of grave and serious concern to the cattle industry of the United States until this danger was removed by the inspection of this Department. It is absolutely essential, therefore, that this cattle industry should continue to be protected as far as possible by separating the dangerous cattle and by the adoption of efficient methods of disinfection.

Inspectors will be instructed to see that disinfection is properly done, and it is expected that transportation companies will promptly put into operation the above methods.

J. STERLING MORTON,
Secretary.

SPECIAL ORDER CONCERNING IMPORTATION OF CATTLE FROM MEXICO.

U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF THE SECRETARY,
Washington, D. C., April 15, 1895.

It is hereby ordered that the regulations of this Department, issued February 5, 1895, defining the quarantine line on account of Texas or splenetic fever, and the regulations of February 11, 1895, concerning the importation of animals into the United States, be modified so far as they relate to the admission of Mexican cattle into the United States as follows:

Mexican cattle which have been inspected by an inspector of this Department and found free from any infectious or contagious disease may be admitted into that portion of the State of California south and west of the said quarantine line through the port of San Diego, and into that portion of the State of Texas south and east of the said quarantine line through the ports of Eagle Pass and Laredo, for grazing or for immediate slaughter. Cattle may be admitted through the port of El Paso for immediate slaughter only. In all cases where cattle are admitted for immediate slaughter they shall be shipped by rail or boat to the point of destination.

On and after May 1, 1895, cattle will be admitted at the port of Brownsville, Tex., for grazing and immediate slaughter.

J. STERLING MORTON,
Secretary.

RULES AND REGULATIONS FOR THE SUPPRESSION AND EXTIRPATION OF CONTAGIOUS, INFECTIOUS, AND COMMUNICABLE DISEASES AMONG THE DOMESTIC ANIMALS OF THE UNITED STATES.

[Prepared by the Commissioner of Agriculture, April 15, 1887.]

In pursuance of an act of Congress entitled "An act for the establishment of a Bureau of Animal Industry, to prevent the exportation of diseased cattle, and to provide means for the suppression and extirpation of pleuro-pneumonia and other contagious diseases among domestic animals," approved the 29th day of May, 1884, and of section 3 of said act, the following rules and regulations are hereby prepared and adopted for the speedy and effectual suppression and extirpation of contagious, infectious, and communicable diseases among the domestic animals of the United States:

RULES AND REGULATIONS.

1. Whenever it shall come to the knowledge of the Chief of the Bureau of Animal Industry of the Department of Agriculture that there exists, or there is good cause to believe there exists, any contagious, infectious, or communicable disease among domestic animals in any part of the United States, and he believes there is danger of such disease spreading to other States or Territories, he shall at once direct an inspector to make an investigation as to the existence of said disease.

2. Said inspector shall at once proceed to the locality where said disease is believed to exist and make an examination of the animals said to be affected with disease, and report the result of such examination to the Chief of the Bureau of Animal Industry.

3. Should the inspector on such investigation find that a contagious, infectious, or communicable disease exists among the animals examined, and especially pleuro-pneumonia, he shall direct the temporary quarantine of said animals and the herds among which they are, and adopt such sanitary measures as may be necessary to prevent the spread of the disease, and report his action to the Chief of the Bureau. He will

further notify in writing the owner or owners, or person or persons in charge of such animal or animals, of the existence of the contagious disease, and that said animal or animals have been placed in quarantine, and warn him or them from moving said animal or animals under penalty of sections 6 and 7 of the act of Congress approved May 29, 1884.

4. When the Chief of the Bureau of Animal Industry is satisfied of the existence of any contagious disease among domestic animals in any locality of the United States, and especially of pleuro-pneumonia, and that there is danger of said disease spreading to other States or Territories, he will report the same to the Commissioner of Agriculture, who will quarantine said locality in the mode and manner as provided in rule 12. He shall cause a thorough examination of all animals of the kind diseased in said locality, and all such animals found diseased he will cause to be slaughtered. He shall establish a quarantine for a period of not less than ninety days of all animals that have come in contact with diseased animals, or have been on premises or in buildings on or in which diseased animals have been, or have been in any way exposed to disease; and shall make and enforce all such sanitary regulations as the exigencies of the case may require. He will cause to be disinfected in such manner as he deems best all sheds, corrals, yards, barns, and buildings in which diseased animals have been, and until such premises and buildings have been so disinfected and declared free from contagion by a certificate in writing signed by an inspector of the Bureau of Animal Industry, no animal or animals shall be permitted to go upon or into said premises and buildings. Should, however, any animal or animals be put upon said premises or into said buildings in violation of this rule and regulation, then such animal or animals shall be placed in quarantine for a period of not less than ninety days, and said premises or buildings be again disinfected. Said second disinfection and the quarantine of such animals to be at the expense of the owner of said premises or buildings.

5. All animals quarantined by order of the Chief of the Bureau of Animal Industry shall have a chain fastened with a numbered lock placed around their horns, or, in case of hornless animals, placed around their necks; and a record will be kept showing the number of lock placed upon each animal, name and character of animal and marks of identification, name of owner, locality, and date of quarantine. The Chief of the Bureau, however, may, in his discretion, in place of chaining said animals, cause the animals to be branded in such manner as he may designate, or may place a guard over the same.

6. All animals quarantined will be deemed and considered as "affected with contagious disease," and any person or persons moving said quarantined animals from the infected district will be prosecuted under sections 6 and 7 of the act of Congress establishing the Bureau of Animal Industry approved May 29, 1884.

7. Whenever in the judgment of the Chief of the Bureau of Animal Industry it becomes necessary to kill animals that have been exposed to the contagious disease known as pleuro-pneumonia, in order to prevent the spread of said disease from one State or Territory to another, he shall cause the same to be slaughtered.

8. All animals diseased with pleuro-pneumonia, and all animals exposed to pleuro-pneumonia, that have been condemned to be slaughtered, shall be first appraised as to their value at the time of their condemnation. Said appraisement shall be made in the mode and manner provided for by the law of the State in which they are located, and such compensation on their appraised value will be paid as is provided for by the law of such State. In case such State has no law for the appraisement of the value of animals diseased with pleuro-pneumonia, or that have been exposed to pleuro-pneumonia, or either, then the Chief of the Bureau of Animal Industry shall direct an inspector of the Bureau to convene a board of appraisers to consist of three members, one of whom said inspector shall appoint, one to be appointed by the owner of the animal or animals condemned, and these two will appoint the third; in case the said owner shall neglect or refuse to name an appraiser, then by two appraisers to be appointed by said inspector. This board will appraise the value of the animals condemned and certify to the same in writing under oath, and the amount so fixed by said board shall be paid to the owner of the animals condemned. Should the owner of the animals condemned be dissatisfied with the appraisement, he may appeal from said appraisement to the circuit court of the United States, and the amount found by said court to be the value of the condemned animals will be paid to the owner.

9. Whenever it is deemed necessary by the Chief of the Bureau of Animal Industry to supervise and inspect any of the lines of transportation operating in the United States that do business in and through more than one State or connect with lines doing business in and through other States, and the boats, cars, and stock yards in connection with the same, he shall designate suitable inspectors for that purpose, and make all necessary regulations for the quarantine and disinfection of all stock yards, cars, boats, and other vehicles of transportation in which have been, or in which have been transported, animals affected with a contagious disease or suspected to have been affected with such a disease. Such cars and other vehicles of transportation declared in quarantine shall not be again used to transport, store, or shelter animals or merchandise until certified to be free of contagion by a certificate signed by the inspector supervising their disinfection, and such stock yards shall not again have animals placed in them until likewise declared free of contagion.

10. All quarantined stock, premises, and buildings will be under the charge and supervision of an inspector of the Bureau of Animal

Industry, and shall be in no case free from quarantine until so ordered by the Chief of the Bureau.

11. Whenever any inspector of the Bureau of Animal Industry is prevented or obstructed or interfered with in the discharge of his duty in the examining of animals suspected to have a contagious disease, or in placing under quarantine animals or premises, or in disinfecting them, he will report the same to the Chief of the Bureau. He will also call upon the sheriff or other police authorities of the locality where said obstruction or interference occurs for aid and protection in the performing of his duty. Should such sheriff or police authorities neglect or refuse to render such aid and protection he will then apply to the United States marshal of said district for the necessary force and assistance needed to protect him in the carrying out of the duties imposed upon him by these rules and regulations and the provisions of the law by authority of which they are made. He will also file with the United States district attorney information of all the facts connected with such obstruction and interference, and the names of the party or parties causing the same.

12. Should from any cause the Chief of the Bureau of Animal Industry find that it is impossible to enforce these rules and regulations in any State, and that in consequence thereof there is great danger that pleuro-pneumonia will spread from said State to other States and Territories, he will report the same to the Commissioner of Agriculture. Thereupon the Commissioner of Agriculture, if he believes the exigency of the case requires it, will declare said State, in which pleuro-pneumonia exists and in which it is impossible to carry out these rules and regulations, to be quarantined against the exportation of animals of the kind diseased to any other State, Territory, or foreign country. Said order of the Commissioner declaring the quarantine of a State will be published in at least two papers in said State once a week during the existence of said quarantine, and in such other papers as he may select. Notification of the order declaring said quarantine will be certified to the governor of the State quarantined, as well as to the governors of all other States and Territories, and to the agents of all transportation companies doing business in or through said State. All animals of the kind quarantined against in said State will be deemed as animals "affected with contagious disease," and any person moving or transporting any of said animals to any other State or Territory, or delivering any of such animals to any transportation company to be so transported, will be prosecuted under sections 6 and 7 of the act of Congress approved May 29, 1884. Provided, however, that any animal of the kind quarantined against that has been examined by an inspector of the Bureau of Animal Industry and by a certificate in writing signed by such inspector declared to be free from pleuro-pneumonia, may be exported to any other State or Territory; and provided further, that said animal shall be exported within forty-eight

hours after such examination and signing of said certificate, so that said animal may not be exposed to disease before leaving said State.

13. Before giving the certificate provided for by rule 12 the inspector must be furnished with an affidavit made by two reputable and disinterested persons, stating that they have known the animals to be examined for a period of six months immediately prior to the date of examination, and that during that time the animals have not been exposed to pleuro-pneumonia; that they have not been in any of the buildings or on any of the premises, or among any of the herds known to be affected with pleuro-pneumonia, or suspected to be so affected. The inspector may also require further proof as to whether said animals to be examined have been exposed to pleuro-pneumonia.

14. All rules and regulations heretofore made are hereby revoked, and these rules and regulations will be in full force and effect on and after the 15th day of April, 1887.

NORMAN J. COLMAN,
Commissioner of Agriculture.

ACTS OF CONGRESS.

(Under which the foregoing rules and regulations are made.)

[PUBLIC—No. 41.]

An act for the establishment of a Bureau of Animal Industry, to prevent the exportation of diseased cattle, and to provide means for the suppression and extirpation of pleuro-pneumonia and other contagious diseases among domestic animals.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Commissioner of Agriculture shall organize in his Department a Bureau of Animal Industry, and shall appoint a Chief thereof, who shall be a competent veterinary surgeon, and whose duty it shall be to investigate and report upon the condition of domestic animals of the United States, their protection and use, and also inquire into and report the causes of contagious, infectious, and communicable diseases among them, and the means for the prevention and cure of the same, and to collect such information on these subjects as shall be valuable to the agricultural and commercial interests of the country; and the Commissioner of Agriculture is hereby authorized to employ a force sufficient for this purpose, not to exceed twenty persons at any one time. The salary of the Chief of said Bureau shall be three thousand dollars per annum; and the Commissioner shall appoint a clerk for said Bureau, with a salary of one thousand five hundred dollars per annum.

SEC. 2. That the Commissioner of Agriculture is authorized to appoint two competent agents, who shall be practical stock raisers or experienced business men familiar with questions pertaining to commercial transactions in live stock, and whose duty it shall be, under the instructions of the Commissioner of Agriculture, to examine and report upon the best methods of treating, transporting, and caring for animals, and the means to be adopted for the suppression and extirpation of contagious pleuro-pneumonia, and to provide against the spread of other dangerous, contagious, infectious, and communicable diseases. The compensation of said agents shall be at the rate of ten dollars per diem, with all necessary expenses while engaged in the actual performance of their duties under this act, when absent from their usual place of business or residence as such agent.

SEC. 3. That it shall be the duty of the Commissioner of Agriculture to prepare such rules and regulations as he may deem necessary for the speedy and effectual suppression and extirpation of said diseases, and to certify such rules and regulations to the executive authority of each State and Territory, and invite said authorities to cooperate in the execution and enforcement of this act. Whenever the plans and methods of the Commissioner of Agriculture shall be accepted by any State or Territory in which pleuro-pneumonia or other contagious, infectious, or communicable disease is declared to exist, or such State or Territory shall have adopted plans and methods for the suppression and extirpation of said diseases, and such plans and methods shall be accepted by the Commissioner of Agriculture, and whenever the governor of a State or other properly constituted authorities signify their readiness to cooperate for the extinction of any contagious, infectious, or communicable disease in conformity with the provisions of this act, the Commissioner of Agriculture is hereby authorized to expend so much of the money appropriated by this act as may be necessary in such investigations, and in such disinfection and quarantine measures as may be necessary to prevent the spread of the disease from one State or Territory into another.

SEC. 4. That in order to promote the exportation of live stock from the United States the Commissioner of Agriculture shall make special investigation as to the existence of pleuro-pneumonia, or any contagious, infectious, or communicable disease, along the dividing lines between the United States and foreign countries, and along the lines of transportation from all parts of the United States to ports from which live stock are exported, and make report of the results of such investigation to the Secretary of the Treasury, who shall, from time to time, establish such regulations concerning the exportation and transportation of live stock as the results of said investigations may require.

SEC. 5. That to prevent the exportation from any port of the United States to any port in a foreign country of live stock affected with any contagious, infectious, or communicable disease, and especially pleuro-pneumonia, the Secretary of the Treasury be, and he is hereby, authorized to take such steps and adopt such measures, not inconsistent with the provisions of this act, as he may deem necessary.

SEC. 6. That no railroad company within the United States, or the owners or masters of any steam or sailing or other vessel or boat, shall receive for transportation or transport, from one State or Territory to another, or from any State into the District of Columbia, or from the District into any State, any live stock affected with any contagious, infectious, or communicable disease, and especially the disease known as pleuro-pneumonia; nor shall any person, company, or corporation deliver for such transportation to any railroad company, or master or owner of any boat or vessel, any live stock, knowing them to be affected with any contagious, infectious, or communicable disease; nor shall any person, company, or corporation drive on foot or transport in private conveyance from one State or Territory to another, or from any State into the District of Columbia, or from the District into any State, any live stock, knowing them to be affected with any contagious, infectious, or communicable disease, and especially the disease known as pleuro-pneumonia: *Provided*, That the so called splenetic or Texas fever shall not be considered a contagious, infectious, or communicable disease within the meaning of sections four, five, six, and seven of this act, as to cattle being transported by rail to market for slaughter, when the same are unloaded only to be fed and watered in lots on the way thereto.

SEC. 7. That it shall be the duty of the Commissioner of Agriculture to notify, in writing, the proper officials or agents of any railroad, steamboat, or other transportation company doing business in or through any infected locality, and by publication in such newspapers as he may select, of the existence of said contagion; and any person or persons operating any such railroad, or master or owner of any boat or vessel, or owner or custodian of or person having control over such cattle or other live stock within such infected district, who shall knowingly violate the provisions of section six of this act, shall be guilty of a misdemeanor, and, upon conviction, shall be punished by a fine of not less than one hundred dollars nor more than five thousand dollars, or by imprisonment for not more than one year, or by both such fine and imprisonment.

SEC. 8. That whenever any contagious, infectious, or communicable disease affecting domestic animals, and especially the disease known as pleuro-pneumonia, shall be brought into or shall break out in the District of Columbia, it shall be the duty of the Commissioners of said District to take measures to suppress the same promptly and to prevent the same from spreading; and for this purpose the said Commissioners are hereby empowered to order and require that any premises, farm or farms, where such disease exists, or has existed, be put in quarantine; to order all or any animals coming into the District to be detained at any place or places for the purpose of inspection and examination; to prescribe regulations for and require the destruction of animals affected with contagious, infectious, and communicable disease, and for the proper disposition of their hides and carcasses; to prescribe regulations for disinfection, and such other regulations as they may deem necessary to prevent infection or contagion being communicated, and shall report to the Commissioner of Agriculture whatever they may do in pursuance of the provisions of this section.

SEC. 9. That it shall be the duty of the several United States district attorneys to prosecute all violations of this act which shall be brought to their notice or knowledge by any person making the complaint under oath; and the same shall be heard before any district or circuit court of the United States or Territorial court holden within the district in which the violation of this act has been committed.

SEC. 10. That the sum of one hundred and fifty thousand dollars, to be immediately available, or so much thereof as may be necessary, is hereby appropriated, out of any moneys in the Treasury not otherwise appropriated, to carry into effect the provisions of this act.

SEC. 11. That the Commissioner of Agriculture shall report annually to Congress, at the commencement of each session, a list of the names of all persons employed, an itemized statement of all expenditures under this act, and full particulars of means adopted and carried into effect for the suppression of contagious, infectious, or communicable diseases among domestic animals.

Approved May 29, 1884.

[PUBLIC—NO. 247.]

An act providing for an inspection of meats for exportation, prohibiting the importation of adulterated articles of food or drink, and authorizing the President to make proclamation in certain cases, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Secretary of Agriculture may cause to be made a careful inspection of salted pork and bacon intended for exportation, with a view to determining whether the same is wholesome, sound and fit for human food, whenever the laws, regulations, or orders of the Government of any foreign country to which such pork or bacon is to be exported shall require inspection thereof relating to the importation thereof into such country, and also whenever any buyer, seller, or exporter of such meats intended for exportation shall request the inspection thereof.

Such inspection shall be made at the place where such meats are packed or boxed, and each package of such meats so inspected shall bear the marks, stamps, or other device for identification provided for in the last clause of this section: *Provided,* That an inspection of such meats may also be made at the place of exportation if an inspection has not been made at the place of packing, or if, in the opinion of the Secretary of Agriculture, a reinspection becomes necessary. One copy of any certificate issued by any such inspector shall be filed in the Department of Agriculture; another copy shall be attached to the invoice of each separate shipment of such meat, and a third copy shall be delivered to the consignor or shipper of meat as evidence that packages of salted pork and bacon have been inspected in accordance with the provisions of this act and found to be wholesome, sound, and fit for human food; and for the identification of the same such marks, stamps, or other devices as the Secretary of Agriculture may by regulation prescribe shall be affixed to each of such packages.

Any person who shall forge, counterfeit, or knowingly and wrongfully alter, deface, or destroy any of the marks, stamps, or other devices provided for in this section on any package of any such meats, or who shall forge, counterfeit, or knowingly and wrongfully alter, deface, or destroy any certificate in reference to meats provided for in this section, shall be deemed guilty of a misdemeanor, and on conviction thereof shall be punished by a fine not exceeding one thousand dollars or imprisonment not exceeding one year, or by both said punishments, in the discretion of the court.

SEC. 2. That it shall be unlawful to import into the United States any adulterated or unwholesome food or drug or any vinous, spirituous or malt liquors, adulterated or mixed with any poisonous or noxious chemical, drug, or other ingredient injurious to health. Any person who shall knowingly import into the United States any such adulterated food or drug, or drink, knowing or having reasons to believe the same to be adulterated, being the owner or the agent of the owner, or the consignor or consignee of the owner, or in privity with them, assisting in such unlawful act, shall be deemed guilty of a misdemeanor, and liable to prosecution therefor in the district court of the United States for the district into which such property is imported; and, on conviction, such person shall be fined in a sum not exceeding one thousand dollars for each separate shipment, and may be imprisoned by the court for a term not exceeding one year, or both, at the discretion of the court.

SEC. 3. That any article designed for consumption as human food or drink, and any other article of the classes or description mentioned in this act, which shall be imported into the United States contrary to its provisions, shall be forfeited to the United States, and shall be proceeded against under the provisions of chapter eighteen of title thirteen of the Revised Statutes of the United States; and such imported property so declared forfeited may be destroyed or returned to the importer for exportation from the United States after the payment of all costs and expenses, under such regulations as the Secretary of the Treasury may prescribe; and the Secretary of the Treasury may cause such imported article to be inspected or examined in order to ascertain whether the same have been so unlawfully imported.

SEC. 4. That whenever the President is satisfied that there is good reason to believe that any importation is being made, or is about to be made, into the United States from any foreign country of any article used for human food or drink that is adulterated to an extent dangerous to the health or welfare of the people of the United States, or any of them, he may issue his proclamation suspending the importation of such articles from such country for such period of time as he may think necessary to prevent such importation; and during such period it shall be unlawful to import into the United States from the countries designated in the proclamation of the President any of the articles, importation of which is so suspended.

SEC. 5. That whenever the President shall be satisfied that unjust discriminations are made by or under the authority of any foreign state against the importation to or sale in such foreign state of any product of the United States, he may direct that such products of such foreign state so discriminating against any product of the United States as he may deem proper shall be excluded from importation to the United States; and in such case he shall make proclamation of his direction in the premises, and therein name the time when such direction against importation shall take effect, and after such date the importation of the articles named in such proclamation shall be unlawful. The President may at any time revoke, modify, terminate, or renew any such direction as, in his opinion, the public interest may require.

SEC. 6. That the importation of neat cattle, sheep, and other ruminants, and swine, which are diseased or infected with any disease, or which shall have been exposed to such infection within sixty days next before their exportation, is hereby prohibited; and any person who shall knowingly violate the foregoing provision shall be deemed guilty of a misdemeanor, and shall, on conviction, be punished by a fine not exceeding five thousand dollars, or by imprisonment not exceeding three years, and any vessel or vehicle used in such unlawful importation with the knowledge of the master or owner of said vessel or vehicle that such importation is diseased or has been exposed to infection as herein described, shall be forfeited to the United States.

SEC. 7. That the Secretary of Agriculture be, and is hereby, authorized, at the expense of the owner, to place and retain in quarantine all neat cattle, sheep, and other ruminants, and all swine, imported into the United States, at such ports as he may designate for such purposes, and under such conditions as he may by regulation prescribe, respectively, for the several classes of animals above described; and for this purpose he may have and maintain possession of all lands, buildings, tools, fixtures, and appurtenances now in use for the quarantine of neat cattle, and hereafter purchase, construct, or rent as may be necessary, and he may appoint veterinary surgeons, inspectors, officers, and employees by him deemed necessary to maintain such quarantine, and provide for the execution of the other provisions of this act.

SEC. 8. That the importation of all animals described in this act into any port in the United States, except such as may be designated by the Secretary of Agriculture, with the approval of the Secretary of the Treasury, as quarantine stations, is hereby prohibited; and the Secretary of Agriculture may cause to be slaughtered such of the animals named in this act as may be, under regulations prescribed by him, adjudged to be infected with any contagious disease, or to have been exposed to infection so as to be dangerous to other animals; and that the value of animals so slaughtered as being so exposed to infection, but not infected, may be ascertained by the agreement of the Secretary of Agriculture and owners thereof, if practicable; otherwise, by the appraisal by two persons familiar with the character and value of such property, to be appointed by the Secretary of Agriculture, whose decision, if they agree, shall be final; otherwise, the Secretary of Agriculture shall decide between them, and his decision shall be final; and the amount of the value thus ascertained shall be paid to the owner thereof out of money in the Treasury appropriated for the use of the Bureau of Animal Industry; but no payment shall be made for any animal imported in violation of the provisions of this act. If any animal, subject to quarantine according to the provisions of this act, are brought into any port of the United States where no quarantine station is established, the collector of such port shall require the same to be conveyed by the vessel on which they are imported or are found to the nearest quarantine station, at the expense of the owner.

SEC. 9. That whenever, in the opinion of the President, it shall be necessary for the protection of animals in the United States against infectious or contagious diseases, he may, by proclamation, suspend the importation of all or any class of animals for a limited time, and may change, modify, revoke, or renew such proclamation, as the public good may require; and during the time of such suspension the importation of any such animals shall be unlawful.

SEC. 10. That the Secretary of Agriculture shall cause careful inspection to be made by a suitable officer of all imported animals described in this act, to ascertain whether such animals are infected with contagious diseases or have been exposed to infection so as to be dangerous to other animals, which shall then either be placed in quarantine or dealt with according to the regulations of the Secretary of Agriculture; and all food, litter, manure, clothing, utensils, and other appliances that have been so related to such animals on board ship as to be judged liable to convey infection shall be dealt with according to the regulations of the Secretary of Agriculture; and the Secretary of Agriculture may cause inspection to be made of all animals described in this act intended for exportation, and provide for the disinfection of all vessels engaged in the transportation thereof, and of all barges or other vessels used in the conveyance of such animals intended for export to the ocean steamer or other vessels, and of all head ropes and other appliances used in exportation, by such orders and regulations as he may prescribe; and if, upon such inspection, any such animals shall be adjudged, under the regulations of the Secretary of Agriculture, to be infected or to have been exposed to infection so as to be dangerous to other animals, they shall not be allowed to be placed upon any vessel for exportation; the expense of all inspection and disinfection provided for in the section to be borne by the owner of the vessels on which such animals are exported.

Approved August 30, 1890.

[PUBLIC—No. 521.]

An act to provide for the safe transport and humane treatment of export cattle from the United States to foreign countries, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Secretary of Agriculture is hereby authorized to examine all vessels which are to carry export cattle from the ports of the United States to foreign countries, and to prescribe by rules and regulations or orders the accommodations which said vessels shall provide for export cattle, as to space, ventilation, fittings, food and water supply, and such other requirements as he may decide to be necessary for the safe and proper transportation and humane treatment of such animals.

SEC. 2. That, whenever the owner, owners, or master of any vessel carrying export cattle shall willfully violate or cause or permit to be violated any rule, regulation, or order made pursuant to the foregoing section, the vessel in respect of which such violation shall occur may be prohibited from again carrying cattle from any port of the United States for such length of time, not exceeding one year, as the Secretary of Agriculture may direct, and such vessel shall be refused clearance from any port of the United States accordingly.

Approved March 3, 1891.

[PUBLIC—No. 555.]

An act to provide for the inspection of live cattle, hogs, and the carcasses and products thereof which are the subjects of interstate commerce, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Secretary of Agriculture shall cause to be made a careful inspection of all cattle intended for export to foreign countries from the United States, at such times and places, and in such manner, as he may think proper, with a view to ascertain whether such cattle are free from disease; and for this purpose he may appoint inspectors, who shall be authorized to give an official certificate clearly stating the condition in which such animals are found, and no clearance shall be given to any vessel having on board cattle for exportation to a foreign country unless the owner or shipper of such cattle has a certificate from the inspector herein authorized to be appointed, stating that said cattle are sound and free from disease.

SEC. 2. That the Secretary of Agriculture shall also cause to be made a careful inspection of all live cattle the meat of which is intended for exportation to any foreign country, at such times and places, and in such manner, as he may think proper, with a view to ascertain whether said cattle are free from disease and their meat sound and wholesome, and may appoint inspectors, who shall be authorized to give an official certificate clearly stating the condition in which such cattle and meat are found, and no clearance shall be given to any vessel having on board any fresh beef for exportation to and sale in a foreign country from any port of the United States until the owner or shipper shall obtain from an inspector appointed under the provisions of this act such certificate.

SEC. 3. The Secretary of Agriculture shall cause to be inspected, prior to their slaughter, all cattle, sheep, and hogs which are subjects of interstate commerce and which are about to be slaughtered at slaughterhouses, canning, salting, packing, or rendering establishments in any State or Territory, the carcasses or products of which are to be transported and sold for human consumption in any other State or Territory or the District of Columbia, and in addition to the aforesaid inspection, there may be made in all cases where the Secretary of Agriculture may deem necessary or expedient, under the rules and regulations to be by him prescribed, a post-mortem examination of the carcasses of all cattle, sheep, and hogs, about to be prepared for human consumption at any slaughterhouse, canning, salting, packing, or rendering establishment in any State or Territory or the District of Columbia, which are the subjects of interstate commerce.

SEC. 4. That said examination shall be made in the manner provided by rules and regulations to be prescribed by the Secretary of Agriculture, and after said examination the carcasses and products of all cattle, sheep, and swine found to be free of disease, and wholesome, sound, and fit for human food, shall be marked, stamped, or labeled for identification as may be provided by said rules and regulations of the Secretary of Agriculture.

Any person who shall forge, counterfeit, or knowingly and wrongfully alter, deface, or destroy any of the marks, stamps, or other devices provided for in the regulations of the Secretary of Agriculture, of any such carcasses or their products, or who shall forge, counterfeit, or knowingly and wrongfully alter, deface, or destroy any certificate provided for in said regulations, shall be deemed guilty of a misdemeanor, and on conviction thereof shall be punished by a fine not exceeding one thousand dollars, or imprisonment not exceeding one year, or by both said punishments, in the discretion of the court.

SEC. 5. That it shall be unlawful for any person to transport from one State or Territory or the District of Columbia into any other State or Territory or the District of Columbia, or for any person to deliver to another for transportation from one State or Territory or the District of Columbia into another State or Territory or the District of Columbia the carcasses of any cattle, sheep, or swine, or the food products thereof, which have been examined in accordance with the provisions of sections three and four of this act, and which on said examination have been declared by the inspector making the same to be unsound or diseased. Any person violating the provisions of this section shall be deemed guilty of a misdemeanor and punished for each offense as provided in section four of this act.

SEC. 6. That the inspectors provided for in sections one and two of this act shall be authorized to give official certificates of the sound and wholesome condition of the cattle, sheep, and swine, their carcasses and products described in sections three and four of this act, and one copy of every certificate granted under the provisions of this act shall be filed in the Department of Agriculture, another copy shall be delivered to the owner or shipper, and when the cattle, sheep, and swine, or their carcasses and products are sent abroad, a third copy shall be delivered to the chief officer of the vessel on which the shipment shall be made.

SEC. 7. That none of the provisions of this act shall be so construed as to apply to any cattle, sheep, or swine slaughtered by any farmer upon his farm, which may be transported from one State or Territory or the District of Columbia into another State or Territory or the District of Columbia: *Provided, however*, That if the carcasses of such cattle, sheep, or swine go to any packing or canning establishment and are intended for transportation to any other State or Territory or the District of Columbia as hereinbefore provided, they shall there be subject to the post-mortem examination provided for in sections three and four of this act

Approved March 3, 1891.

[PUBLIC—No. 102.]

An act making appropriations for the Department of Agriculture for the fiscal year ending June thirtieth, eighteen hundred and ninety-six.

SALARIES AND EXPENSES, BUREAU OF ANIMAL INDUSTRY: For carrying out the provisions of the act of May twenty-ninth, eighteen hundred and eighty-four, establishing the Bureau of Animal Industry, and of the act of August thirtieth, eighteen hundred and ninety, providing for an inspection of meats and animals, also the provisions of the act of March third, eighteen hundred and ninety-one, providing for the inspection of live cattle, hogs, and the carcasses and products thereof which are the subjects of interstate and foreign commerce, and for other purposes, the sum of eight hundred thousand dollars; and the Secretary of Agriculture is hereby authorized to use any part of this sum he may deem necessary or expedient, and in such manner as he may think best, in the collection of information concerning live stock, dairy, and other animal products, and to prevent the spread of pleuro-pneumonia, tuberculosis, sheep scab, and other diseases of animals, and for this purpose to employ as many persons as he may deem necessary, including one thousand dollars additional temporary compensation to the Chief of the Bureau of Animal Industry, and to expend any part of this sum in the purchase and destruction of diseased or exposed animals and the quarantine of the same whenever in his judgment it is essential to prevent the spread of pleuro-pneumonia, tuberculosis, or other diseases of animals from one State into another, and for printing and publishing such reports relating to animal industry as he may direct; and the Secretary is hereby authorized to rent a suitable building in the District of Columbia, at an annual rental of not exceeding one thousand two hundred dollars, to be used as a laboratory for said Bureau of Animal Industry: *Provided*, That section two of the act entitled "An act to provide for the inspection of live cattle, hogs, and the carcasses and products thereof which are the subjects of interstate commerce, and for other purposes," approved March third, eighteen hundred and ninety-one, be amended to read as follows:

"SEC. 2. That the Secretary of Agriculture shall also cause to be made a careful inspection of all live cattle, the meat of which, fresh, salted, canned, corned, packed, cured, or otherwise prepared, is intended for exportation to any foreign country, at such times and places, and in such manner as he may think proper, with a view to ascertain whether said cattle are free from disease, and their meat sound and wholesome, and may appoint inspectors who shall be authorized to give an official certificate clearly stating the condition in which such cattle and meat are found, and no clearance shall be given to any vessel having on board any fresh, salted, canned, corned, or packed beef being the meat of cattle killed after the passage of this act for exportation to and sale in a foreign country from any port in the United States until the owner or shipper shall obtain from an inspector appointed under the provisions of this act a certificate that said cattle were free from disease and that their meat is sound and wholesome."

Also that section four of said act be so amended as to read as follows:

"SEC. 4. That said examination shall be made in the manner provided by rules and regulations to be prescribed by the Secretary of Agriculture, and after said examination the carcasses and products of all cattle, sheep, and swine found to be free of disease and wholesome, sound, and fit for human food shall be marked, stamped, or labeled for identification as may be provided by said rules and regulations of the Secretary of Agriculture. Any person who shall forge, counterfeit, simulate, imitate, falsely represent, or use without authority, or knowingly and wrongfully alter, deface, or destroy any of the marks, stamps, or other devices provided for in the regulations of the Secretary of Agriculture, of any such carcasses or their products, or who shall forge, counterfeit, simulate, imitate, falsely represent, or use without authority, or knowingly and wrongfully alter, deface, or destroy any certificate or stamp provided in said regulations, shall be deemed guilty of a misdemeanor, and on conviction thereof shall be punished by a fine not exceeding one thousand dollars, or imprisonment not exceeding one year, or by both said punishments, in the discretion of the court."

The Secretary of Agriculture is hereby authorized to make such rules and regulations as he may decide to be necessary to prevent the transportation from one State or Territory or the District of Columbia into any other State or Territory or the District of Columbia, or to any foreign country, of the condemned carcasses or parts of carcasses of cattle, sheep, and swine, which have been inspected in accordance with the provisions of this act. Any person, company, or corporation owning or operating any such slaughterhouse, abattoir, or meat curing, packing, or canning establishment, or any employee of the same, that shall willfully violate any provision of this act shall be deemed guilty of a misdemeanor, and, on conviction thereof, shall be punished for each offense by a fine not exceeding one thousand dollars or imprisonment not exceeding one year, or by both said punishments, in the discretion of the court.

QUARANTINE STATIONS FOR NEAT CATTLE: To establish and maintain quarantine stations, and to provide proper shelter for and care of neat cattle imported, at such ports as may be deemed necessary, twelve thousand dollars.

That whenever the Secretary of Agriculture shall certify to the President of the United States what countries or parts of countries are free from contagious or infectious diseases of domestic animals, and that neat cattle and hides can be imported from such countries without danger to the domestic animals of the United States, the President of the United States may suspend the prohibition of the importation of neat cattle and hides in the manner provided by law. That the President of the United States be, and he is hereby, authorized to cause correspondence and negotiation to be had, through the Department of State or otherwise, with the authorities of the Kingdom of Great Britain, for the purpose of securing the abrogation or modification of the regulations now enforced by said authorities which require cattle imported into Great Britain from the United States of America to be slaughtered at the port of entry, and prohibiting the same from being carried alive to other places in said Kingdom.

That the Secretary of Agriculture shall determine and certify to the Secretary of the Treasury what are recognized breeds and pure-bred animals, under the provisions of paragraph three hundred and seventy-three of the tariff act of eighteen hundred and ninety-four.

Approved March 2, 1895.

SECTIONS OF THE REVISED STATUTES REFERRING TO THE TRANSPORTATION OF ANIMALS.

SEC. 4386. No railroad company within the United States whose road forms any part of a line of road over which cattle, sheep, swine or other animals are conveyed from one State to another, or the owners or masters of steam, sailing, or other vessels carrying or transporting cattle, sheep, swine, or other animals from one State to another, shall confine the same in cars, boats, or vessels of any description *for a longer period than twenty-eight consecutive hours*, without unloading the same for rest, water, and feeding, for a *period of at least five consecutive hours*, unless prevented from unloading by storm or other accidental causes. In estimating such confinement the time during which the animals have been confined without such rest on connecting roads from which they are received shall be included, it being the intent of this section to prohibit their continuous confinement beyond the period of twenty-eight hours, except upon contingencies hereinbefore stated.

SEC. 4387. Animals so unloaded shall be properly fed and watered during such rest by the owner or person having the custody thereof, or in case of his default in so doing, then by the railroad company or owners or masters of boats or vessels transporting the same, at the expense of the owner or person in custody thereof; and such company, owners, or masters shall in such case have a lien upon such animals for food, care, and custody furnished, and shall not be liable for any detention of such animals.

SEC. 4388. Any company, owner, or custodian of such animals who knowingly and willingly fails to comply with the provisions of the two preceding sections shall, for every such failure, be liable for and forfeit and pay a penalty of not less than one hundred nor more than five hundred dollars. But when animals are carried in cars, boats, or other vessels in which they can and do have proper food, water, space, and opportunity to rest, the provisions in regard to their being unloaded shall not apply.

SEC. 4389. The penalty created by the preceding section shall be recovered by civil action in the name of the United States, in the circuit or district court of the United States, holden within the district where the violation may have been committed, or the person or corporation resides or carries on its business; and it shall be the duty of all United States marshals, their deputies and subordinates, to prosecute all violations which come to their notice or knowledge.

BULLETIN No. 10.

U. S. DEPARTMENT OF AGRICULTURE.
BUREAU OF ANIMAL INDUSTRY.

CORNSTALK DISEASE,

AND

RABIES IN CATTLE.

AN INVESTIGATION INTO THE NATURE, CAUSE, AND MEANS OF PREVENTING THE CORNSTALK DISEASE (TOXÆMIA MAIDIS) OF CATTLE. By VERANUS A. MOORE, B. S., M. D.
A DISEASE IN CATTLE NOT DISTINGUISHABLE FROM RABIES. By VERANUS A. MOORE, B. S., M. D.
CHEMICAL EXAMINATION OF CORNSTALKS PRESUMABLY THE CAUSE OF CORNSTALK DISEASE IN CATTLE. By E. A. DE SCHWEINITZ, M. D., PH. D.

Investigations conducted under the direction of
DR. D. E. SALMON,
Chief of the Bureau of Animal Industry.

ISSUED JANUARY, 1896.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1896.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Animal Industry,
Washington, D. C., November 22, 1895.

Sir: I have the honor to transmit herewith for publication a report on the cornstalk disease of cattle, and also one covering investigations of a disease which is apparently identical with rabies. The cornstalk disease has brought heavy losses to the cattle feeders of the Western States; its causation has been an unsolved mystery, and much that has been written about it has been incorrect, misleading, and injurious to the interests of the cattle owners and of the country at large.

The investigations of Dr. Moore are given in detail in this report, and have been conducted with great care and with all the facilities that modern science has placed at our disposal. It is shown conclusively that the cornstalk disease is not a disease of the lungs; that it is not a communicable malady; and that it is not even a bacterial disease.

In the past a great deal of discredit has been brought upon American cattle by statements that the cornstalk disease is an infectious disease; that it is caused by pathogenic bacteria, which might be inoculated from animal to animal, and that the disease is identical with the broncho-pneumonia sometimes found in cattle after ocean transit. There have never been made any observations or experiments which gave reasonable justification for such conclusions.

So far as is known the cornstalk disease only affects cattle which have fed upon cornstalks as they stand in the fields. It comes on suddenly, most of the affected animals die within a short time, and post-mortem examination reveals no signs of pneumonia or broncho-pneumonia.

It has never been shown that the American cattle found affected with broncho-pneumonia in Europe had ever eaten cornstalks in the fields, and certainly they could not have fed in that way for three weeks prior to slaughter. Nor is there any evidence that any cattle have ever suffered in this country from cornstalk disease two or three weeks after they ceased eating the standing cornstalks. This hypothesis, therefore, could not possibly be made to conform with the known facts at the time it was promulgated, and the investigations subsequently made have entirely disproved it.

The report under consideration indicates the real nature of this obscure disease and the means by which it may be avoided. The prevention requires some change in the methods of feeding, but these changes are in the direction of better and more economical farming, and they will tend to increase the income of the farm even if the losses from this disease are not considered.

The chemical examinations by Dr. de Schweinitz of cornstalks from fields where the disease occurred are summarized in his report, and appear to confirm the conclusion reached by Dr. Moore.

The discovery of a disease affecting cattle which is very closely related to, if not identical with, rabies, and which is apparently quite common in certain parts of the West, is extremely interesting, and may lead to the suggestion of appropriate preventive measures. It has not yet been determined whether these cattle were bitten by a rabid animal; but as that is the only known cause of rabies it is probable that further inquiry will show that this mysterious disease arises from the bites of dogs or perhaps of some wild animals that are affected with it.

Very respectfully,

D. E. SALMON,
Chief of the Bureau of Animal Industry.

HON. J. STERLING MORTON,
Secretary of Agriculture.

LETTER OF SUBMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY,
Washington, D. C., July 30, 1895.

SIR: I have the honor to submit herewith a report on the cause, nature, and means of prevention of the cornstalk disease of cattle; also the results of an inquiry into an outbreak of apparently sporadic rabies. The investigations upon which it is based were begun, in accordance with your instructions, in the fall of 1892, and continued more or less constantly until the spring of 1894. I found, contrary to reports, that outbreaks of the cornstalk disease were quite uncommon. The infrequency of their appearance and the insidious nature and rapid course of this disease have rendered it impossible, up to the present time, to obtain all the data necessary to make this report complete in every particular. The numerous observations and experiments made in the course of this investigation, however, have given uniform results which will have much influence in eliminating many of the widespread errors concerning the etiology and importance of this disease, and in causing the discontinuance of many troublesome and ineffective methods of prevention now in vogue. The data obtained indicate a ready means of prevention which has the additional advantage of materially increasing the forage value of the cornstalks.

The term "cornstalk disease," by which this affection is popularly designated, refers simply to the conditions under which the deaths occur. The fact does not appear to be generally considered that agencies already recognized and well understood by veterinarians cause a certain percentage of deaths attributed to this disease. On account of this unrestricted meaning it becomes necessary to limit the popular term to the deaths occurring under more clearly defined conditions, and it is therefore desirable to substitute for it another name. As this disease is of a toxic nature the name *Toxæmia maidis* is proposed. However, as the term "cornstalk disease" is the one by which this malady is known it is used to avoid confusion, with the limitations herein specified, in the text of this article.

The omission of much desired information, especially concerning the symptoms, is due to the extreme difficulty in reaching outbreaks in time to make ante-mortem examinations of the affected animals. The many unsuccessful efforts which were made to obtain these data have indicated that the only practical way of procuring them is to enlist the cooperation of veterinarians and investigators residing within the geographical boundaries of the disease who may, perchance, have the opportunity of recording these at present undetermined facts. In order that the results of others, as well as the outcome of these researches, may be at hand to guide further inquiry, a brief résumé of the various theories advanced and results heretofore obtained is prefixed to the detailed account of these investigations.

While engaged in the above-mentioned researches my attention was called to an outbreak of a mysterious affection of cattle in northern Iowa, which was causing the death of many animals, and which it was thought might possibly be similar to the cornstalk disease. It was learned that outbreaks similar to this occurred quite frequently, but up to that time the nature of the disease was a profound mystery. The investigation of this outbreak led to the diagnosis of rabies. This is of much importance, as it suggests the possibility of the occurrence of rabies in cattle, or a disease not distinguishable from it, without the intervention of rabid animals. There is much evidence to indicate a causal relation between the conditions under which the animals were kept and the disease.

In carrying out these investigations I was assisted in much of the field work and in certain of the experiments by Dr. F. L. Kilborne. Special mention of the work performed by him will be made in the text. The thanks of the Bureau are due to the authorities of the experiment stations of the States of Iowa and Illinois for the use of their bacteriological laboratories, and for all other possible assistance in furthering these inquiries. The uniform courtesy extended by the owners of the affected herds and their assistance and cooperation are likewise acknowledged.

Very respectfully,

VERANUS A. MOORE,
Chief of the Division of Animal Pathology.

Dr. D. E. SALMON,
Chief of the Bureau of Animal Industry.

TABLE OF CONTENTS.

Page.
An Investigation into the Nature, Cause, and Means of Preventing the Cornstalk Disease (*Toxæmia maidis*) of Cattle. By Veranus A. Moore........... 9
  Investigations prior to 1892.. 11
    Investigations by Prof. John Gamgee.................................. 11
    Investigations by Dr. F. S. Billings................................... 13
    Investigations at the Illinois State experiment station.............. 15
  A letter of inquiry and a summary of the replies.......................... 16
  Special Investigations.. 18
    Methods... 18
    Outbreaks... 20
    Cornstalks affected with "corn blight," or the Burrill disease, are free from pathogenic properties.................................. 39
    Feeding diseased cornstalks to rabbits.............................. 42
    Experiments to ascertain the extent to which cornstalk fields in which cattle have died are dangerous.............................. 43
    The bacillus of the Burrill disease of corn.......................... 45
      Description of the bacillus..................................... 46
    Corn smut (*Ustilago maidis*) not fatal to animals.................... 47
    Animals other than cattle not affected.............................. 49
    Chemical analyses... 49
  A Discussion of the Nature of the Disease, Based on the Facts Elicited in the Special Investigations.. 50
    Conditions under which the disease occurred......................... 50
    Symptomatology.. 53
    Morbid anatomy.. 55
    Bacteriological examinations.. 58
    Etiology.. 59
    Economic importance... 62
    Prevention of the diseases.. 64
A Disease in Cattle not Distinguishable from Rabies. By Veranus A. Moore.. 71
  Symptoms and lesions in the cattle examined.............................. 72
  Comparative inoculations.. 77
  Inoculations with the virus originally obtained from steer No. 4........ 77
  Inoculations of rabbits and a calf with the brain of a rabid dog........ 83
Chemical Examination of Cornstalks Presumably the Cause of Cornstalk Disease in Cattle. By E. A. de Schweinitz.................................. 88

ILLUSTRATIONS.

To face page—
Plate I.—Engorgement of Blood in the Liver.............................. 66
Plate II.—Hemorrhages in the Heart Muscle.............................. 68

CORNSTALK DISEASE, AND RABIES IN CATTLE.

AN INVESTIGATION INTO THE NATURE, CAUSE, AND MEANS OF PREVENTING THE CORNSTALK DISEASE (TOXÆMIA MAIDIS) OF CATTLE.

By VERANUS A. MOORE.

(Plates I and II.)

The name "cornstalk disease" has been given to a somewhat mysterious affection from which cattle sometimes suffer while feeding in cornstalk fields late in the fall and early winter. The meaning generally accepted and intended to be conveyed by this term is, that an animal or a number of animals, usually cattle, have died suddenly either while feeding in a cornstalk field or very soon afterwards. From a pathological standpoint, therefore, the term is meaningless, but it has served admirably as a generic term to designate certain fatalities which were not easily explained otherwise. Geographically, this affection is restricted to those sections of the United States where the farmers harvest their corn by picking the ears from the standing stalks, after which cattle are turned into the cornstalk fields. At present, therefore, it is limited in its distribution to the middle and northern portions of the Mississippi Valley.

The disease is very insidious, frequently causing the death of the animals before its presence is suspected. Farmers in the affected region frequently observe that their cattle act perfectly well at night, and on the following morning one or more of them are dead. Local veterinarians and butchers, in making autopsies on the dead animals, report the failure to find lesions sufficient to cause death. Usually all the animals in a herd which die, perish in a single night, or, at the longest, within a few days after the first death occurs. It is generally believed to be invariably fatal, and its symptomatology has not been fully determined.

This affection of cattle has been known to exist for many years. The place and time of its origin, however, are not known, but it seems to be peculiar to the United States, and to have first appeared west of the Alleghany Mountains. Farmers tell us of its occurrence in the Mississippi Valley forty or more years ago. They usually refer to its extensive ravages in 1864–65, and again in 1868. From an historical standpoint, no positive statements can be made concerning it prior to 1868, when the first recorded investigations into its nature and cause were made. After that time the disease seems to have escaped the attention of investigators until 1889, when Dr. Frank S. Billings, of the agricultural experiment station of Nebraska, published the results of his investigations. His "germ theory" and the wide distribution of his publications gave to this disease of cattle an unwarranted conspicuousness, and did much to direct attention to the malady, which he set forth as one of vast economic importance. This aroused the fears of cattle raisers, who depended in part or wholly upon corn fodder to winter their animals, and revived both the interest in this disease and the fear of it.

A careful review of the recorded statements shows that many causes have been assigned to it. The various theories have, for the greater part, been formulated by farmers, cattle raisers, and local veterinarians, and, as might be expected, they are based very largely upon the history of a limited number of outbreaks. A more careful inquiry into the origin of these theories shows that as the disease, with occasional exceptions, occurred in only one or two herds in a neighborhood during the same season, the local conditions affecting these herds were supposed to be favorable to the disease, if not its exciting cause. It would be useless to attempt a consideration of all the causes which have thus been suggested. There are, however, certain theories which appear to possess a greater or less degree of probability, and which can not be gainsaid without positive evidence to the contrary.

It is a curious fact that, while nearly every cattle owner in the sections where this disease prevails, in his experience, entertains one of the popular theories respecting its cause, the other supposed causes have proven to be erroneous or for other reasons are believed to be spurious. There is no uniformity of opinion concerning its etiology. The theories most commonly entertained are appended:

(1) A lack of salt and an insufficient supply of water.

(2) Feeding the cornstalks without an admixture of other food, such as hay, straw, grain, or pasture grass.

(3) Impaction of the third stomach (omasum) due to overfeeding upon the dry cornstalks.

(4) The ingestion of corn smut (*Ustilago maidis*).

(5) A species of bacteria which is found in the lesion of a disease of corn known as "corn blight," or the Burrill disease.

The first three of these theories are of popular origin and are not supported by the general experience of cattle raisers, as will subsequently be shown. The "smut theory," which was somewhat strengthened by the report of Professor Gamgee in 1868–69, has many adherents. So firmly do certain farmers believe it to be the causative agent that they collect and draw out of the field all stalks affected with this fungus. The "germ theory," advanced by Billings, is believed in many sections to be the true explanation of the cause of this malady. The stronghold which the last two theories have on the farmers and cattle raisers of the West, and the inconvenience and often expense involved in carrying out the methods of prevention indicated by them, render necessary a brief consideration of the facts upon which these theories are founded, in order that the results of the investigations here recorded may be understood and properly interpreted. As will be shown, our investigations, which would have verified these theories if they were true, fail to confirm the correctness of any of them.

INVESTIGATIONS PRIOR TO 1892.

THE INVESTIGATIONS OF PROF. JOHN GAMGEE.

In 1868 Gamgee was employed by the United States Department of Agriculture to investigate the cornstalk disease of cattle. Although this disease had been known to exist for many years prior to that time, its ravages had not been sufficiently extensive to enlist any active inquiry into its cause or means of prevention. The "smut theory" appears to have been the prevailing one at that time, and consequently Gamgee's report[1] deals almost exclusively with the effect of improperly prepared food, smuts, etc. Corn smut prevailed to an unusual extent in 1868, and in order to test its etiological value he carried out the following experiment:

> Forty-two pounds of smut free from extraneous material were collected and fed to two cows, together with a small quantity of corn meal and as much cut hay as they could eat. The smut was mixed with corn meal and wet for one animal; the other received it in a dry condition. At first the cattle received 3 ounces of the smut twice daily, but later the quantity was increased to 12 ounces daily. The animal that received the wet meal and smut gained in flesh; the other lost in weight. They were apparently perfectly well at the time the experiment was completed.

The only conclusion which seems to be justified from this experiment is the one Gamgee himself drew, viz, "that smut is not a very active poison in combination with wholesome food." Although the experiment with smut failed to demonstrate any etiological value, he entertained the opinion that the smut and moldy corn were the causative agents in the production of the disease.

In his report a somewhat interesting description of the symptoms of this disease is given. Although the symptomatology is quite exhaustive the text is not clear on the point whether or not the symptoms were observed by himself or reported to him by the owners of the cattle. His description of the symptoms and pathological changes in animals affected with this malady is as follows:

> *Symptoms of the ill effects of smutty corn.*—Cattle fed on smutty cornstalks first denote ill health by constipation. It is true that a farmer may be attracted only by an animal lying down, with an unthrifty look, staring coat, dry muzzle, and perhaps

---

[1] Diseases of Cattle in the United States. U. S. Department of Agriculture, 1869, p. 73.

trembling; or a steer may be noticed "tucked up," with hind limbs drawn under, head depressed, shivering, dullness of eyes, and anxious expression of countenance. In the third variety the animal seems excited, breathes quickly, and is apparently somewhat delirious; indeed, in the condition described by Mr. Cumming, of Ellen, Aberdeenshire, resulting from impaction of the third stomach, as in cases of lead poisoning, nothing is more strange than this delirium, associated as it is sometimes with blindness. A farmer writing me from the West says that when he tried to put a rope around the head of a sick cow, which he found standing with all the symptoms of sickness presented by other animals of the herd which had been with her in the cornfields, she turned and fought furiously. I have seen an animal in this condition tied up in a stall, rush forward, plunge, strike against any obstacle, roar, moan, grunt in breathing, and appear to suffer acutely if touched or disturbed. In other words, with the impaction of the third stomach, which is the essential lesion of the disease, whether induced by smutty stalks, old indigestible stalks that have no smut, or other kind of food or poison, there are two distinct conditions induced—the one of stupor, listlessness, vertigo, and depression of spirits, indicated by the animals standing sullenly until they drop or are relieved; the second is a state of exquisite sensitiveness, a hyperæsthesia of the skin and system generally. The animals are not only excited, but in a state of actual suffering, and die very speedily in a state of coma or in convulsions. The disease does not last long. I have seen an animal linger on four or five days, but usually the whole course of the malady is run in twenty-four to forty-eight hours.

An animal first seems to show costiveness, with a dry mucus over the scanty excrement; and, although apparently undisturbed, and even feeding, may be dead in twelve to twenty-four hours.

The diagnosis of the disease at an early period of its manifestations is therefore important, and it rests on the knowledge of the manner in which animals have been treated and fed (as the simultaneous attack of several animals show), and especially on the observations of a fact that I have usually noticed, that the animals which have eaten most ravenously have been the first and most severely affected. Old cattle may sometimes avoid the smutty food, and young animals eat heartily; the latter will be found the only ones to die.

Post-mortem appearances.—The state of torpor of the alimentary canal of animals affected with this disease is indicated on opening the belly and exposing the stomach to view. In the first stomach, or paunch, corn husks and corn are found in a dry condition. Sometimes the rumen is very full, and gas may have become disengaged in it so as to cause great distention, which is relieved by puncture. The contents of the second stomach, or reticulum, are in the same condition as those of the first, though sometimes mixed with some fluid. The third stomach (manyplies or omasum) is firm, distended, and on being opened the food is found caked between folds, with marked impressions of the papillæ or little eminences which stud the mucus membrane. We find in almost all fevers a similar condition of the third stomach, and indeed in healthy animals it is that part of the digestive organs in which the food is most dry and packed preparatory for solution by the gastric juice and intestinal secretions. But there are other lesions associated with this "caking" of the food in the third stomach, in specific diseases, and its existence without these affords evidence of a primary form of impaction, which has received remarkable names, such as "staking," "bound," "fardel bound," etc. The fourth stomach contains but a scanty quantity of greenish, semidigested matter, is usually reddened somewhat diffusely, and the redness increases at times toward the opening of the small intestines.

The intestine, usually replete with somewhat solid and imperfectly digested food, is usually high colored, especially in the fundus of the cæcum and in the large portion of the colon. The rectum is the seat of ramified redness, and a consistent mucus coats its contents.

Persons have reported a peculiar black color of one lung. This is due only to stagnation of the blood after death in the organ nearest the ground, and the same kind of congestion or settling of the blood is apt to pervade other tissues and organs in the side on which the animal has been lying."

THE INVESTIGATIONS OF DR. F. S. BILLINGS.

In 1889 Billings described the cornstalk disease[1] as an "acute extra-organismal septicæmia, due to micro-organisms belonging to the class of ovoid-belted germs, to which variety of disease also belongs the swine plague, southern cattle plague, Wildseuche, hog cholera, and yellow fever in man."

In January and March, 1888, and in February, 1889, he had occasion to examine pieces of tissue brought from cattle that had died while feeding in cornstalk fields. In the first case the tissues were sent in an unsterilized bottle. From the bits of organs which he thus received he invariably isolated a bacillus which he affirms to be the cause of the disease.

The most interesting part of his investigations was the supposed discovery of the identity of the bacillus which he found in the animal tissues with the one described by Burrill[2] as the cause of a disease in cornstalks. This hypothesis is supported by the fact that by feeding the diseased stalks to a rabbit he produced a fatal disease and from the organs of the dead rabbit he obtained pure cultures of the bacillus. He sent a culture of his bacillus to Burrill, who stated that the organism which he (Billings) had obtained from the organs of dead cattle appeared to be identical with the bacillus which produced the disease in the cornstalks. The correspondence between these two investigators, published by Billings, shows that Burrill was conservative on this question, pointing out obvious resemblances only. The responsibility of the statement that the two bacilli are identical rests with Billings.

Dr. Billings found this micro-organism to be fatal to rabbits, guinea pigs, and mice, when inoculated with small quantities of a pure culture. A rabbit fed with a pure culture died in four days and pure cultures of the bacillus were obtained from each of the organs. A calf and a hog were inoculated subcutaneously with 6 c. c. of a pure bouillon culture. The hog remained well, but the calf became visibly affected. The temperature rose to 41.5° C. (106.7° F.). It became very much emaciated, but eventually recovered. Six days after the inoculation he obtained a pure culture of the bacillus from the blood which he drew from a vein at the root of the tail. In a subsequent experiment he inoculated a calf in the jugular vein with 9 c. c. of a pure culture of the bacillus. The calf died in two days. He also produced fatal results in one of two pigs by feeding them the viscera of the calf which died from the intrajugular inoculation. The other pig sickened but recovered. From the dead pig pure cultures of the bacillus were obtained.

---

[1] Bulletin of the Agricultural Experiment Station of Nebraska, Nos. 7, 8, 9, and 10. Original Investigations of Cattle Disease in Nebraska, 1886–1889, University of Nebraska, 1889, p. 164.

[2] Proceedings of the Society for the Promotion of Agricultural Science, 1889, p. 19.

As would be expected, the pathology of the disease which he gives is extremely meager, owing to the fact that all the tissues he saw were brought to him in a few small bottles or jars. In a few cases they are said to have been much changed by decomposition. Nevertheless he found pneumonia to be one of the lesions characteristic of the disease, and in a subsequent bulletin[1] he places great importance upon this lesion, although he records very few additional observations to sustain the claim. In this publication, however, he attempts to show that chronic interstitial pneumonia in cattle is a sequel to the cornstalk disease. The argument is a confusion of statements from various English and French veterinarians which, for the greater part, appeared after the supposed discovery of cornstalk disease in American cattle at La Villette, France. The importance of lung lesions, which he emphasizes in his second bulletin, appears to have been suggested by the following incident, which temporarily gave to this disease an undue importance from a commercial standpoint:

In 1890 a few animals from a shipload of American cattle landed at La Villette, France, died of pneumonia. They were examined very carefully by Nocard and other French veterinarians. From the diseased lung Nocard obtained a microorganism which corresponded very closely to the description of the bacillus of the cornstalk disease of cattle in America, described by Billings. The publication[2] of this fact gave rise to a temporary supposition that this American cornstalk disease might be a menace to the cattle of Europe, and consequently initial steps were taken to require American cattle to be quarantined against it. The fact was subsequently determined that the bacillus isolated by Nocard was that of a form of bovine pneumonia occasionally met with in America, but not known to be contagious, and the matter was dropped.

The symptomatology as described by Billings is confined to the inoculation disease. These symptoms, however, are so confused with those of swine plague and Texas fever that they are not of diagnostic value.

In a recent popular publication[3] Billings makes the following statements:

> It is now six years since I first discovered a germ in cattle sick and dying from being turned into stalk fields. In many cases I have carefully examined the whole field, and in some of the worst outbreaks smut was most conspicuous by its almost total absence. Again, Gamgee reports that the manure of his cows, which ate 31 pounds each, was black. In all the autopsies I have made—and they run up to the

---

[1] The Corn-Fodder Disease in Cattle and Other Farm Animals, etc. Bulletin Nos. 22 and 23 of the Agricultural Experiment Station of Nebraska, 1892.

[2] Nocard. Une Broncho-pneumonie infectieuse des Bœufs Américains. The Cornstalk Disease. Recueil de Médecine Vétérinaire. Tome VIII (1891), p. 424.

[3] Breeders' Gazette, Vol. XXVI, 1894, p. 340.

fifties—and among all the sick cattle I have seen there was not an indication of any discoloration of the manure unless it was abnormally light yellow in color. Not only in every case personally examined, but in still more where blood and organs have been sent me, have I isolated one and the same germ, but have repeatedly produced the disease in cattle with inoculations of pure cultures. Some six weeks since I received some corn from a field in which cattle were dying in Indiana, and in this corn I found the same germ. I inoculated rabbits with some small fragments of the diseased corn and it killed them, and from them I made pure cultures and injected 2 cubic centimeters into the jugulars of two cattle (2-year-olds) with the result of killing one and making the other very sick, getting the same germ from both.

So long as these people do not seek a germ in the cattle, so long as they ignore so much proof—and it must be remembered that the same germ has been found and proved in our cattle in France, and the same lesions reproduced by inoculation—so long have these men absolutely no right to advocate the smut theory.

He suggests as a means of prevention that all the diseased cornstalks should be destroyed and animals which die of the disease should be carefully buried or burned. The suggestion is also made that in order to detect the presence of the disease the temperature of the cattle should be taken each night, and all animals which give a temperature over 100° F. must be looked upon as suspicious and those in which it exceeds 102° F. as diseased.[1]

INVESTIGATION AT THE ILLINOIS STATE EXPERIMENT STATION.

A single experiment was made at Champaign, Ill., in 1890, in which the etiological importance of corn smut was tested. A bacteriological examination of the organs from an animal that died in a cornstalk field, supposedly of this disease, was also made by Professor Burrill in 1889. A copy of the station experiment report, which I was told included all of the work which has been done on this disease at that place, was kindly furnished by Professor Morrow, with the privilege of publishing.

Experiment No. 98.—(Investigation of a disease which sometimes affects cattle when turned into cornstalk fields):

Mr. J. M. Craig reports a loss of nine yearlings as follows:

The first animal died two weeks before the cattle were turned into the stalks and while running on clover pasture. This animal was left where it died, and the cattle when turned into the stalk field had access to the pasture, but were believed by Mr. Craig not to have frequented it, and it was not thought that the first death had any connection with those that followed.

Mr. Craig turned twelve head of fattening cattle into a cornfield of 22 acres, which he estimated yielded 65 bushels per acre, on Sunday, probably November 24, 1889, and one steer died the Friday following. The remaining cattle were removed, and on the following Wednesday thirteen "stock" cattle were put in the field. Sunday five died, one died Monday, and one Tuesday night. The remaining cattle were then removed.

December 13, at the request of the experiment station Mr. Craig put the six head of cattle which survived again in the field.

---

[1] It seems strange that such a statement as this should be made when standard German authorities give the normal temperature of cattle from 101° to 101.8° F. Dr. E. C. Schroeder, of this Bureau, who has had much experience in applying the tuberculin test for tuberculosis in cattle, finds that the normal temperature of cattle varies from 101° to 103° F.

December 26, one steer was reported sick. The animal was visited and found to be dull, pulse strong, regular, 56 per minute. Took sample of urine at 6.10 p. m., being the third passage in 30 minutes (Lab. No. 167). Urine afterwards passed as follows: 6.20, 6.25, 6.29, and 6.32.

December 20, three yearling steers were purchased by Mr. Craig and placed in the cornfield.

December 23, a steer was perfectly well the previous evening at sundown, but early in the morning it was unable to get up. At 10.30 a. m. the pulse was about 90, membranes pale, breathing 12 per minute. Dr. McIntosh decided that the animal was unable to live and had him killed. A post-mortem examination was made by Dr. McIntosh and every part pronounced normal except a slight exudation in the liver. Examinations and cultures from spleen, liver, etc., by Burrill failed to reveal any organisms.

The six head that were placed in the field December 13 were removed.

To ascertain whether the smut was responsible for the disease, about 60 pounds of it were collected and fed to a grade Jersey steer, with grain and hay as follows:

From December 13, 1889, to January 2, 1890, 120 pounds of grain, 105 pounds of hay, 20 pounds of smut, and 371 pounds of water were given. From January 2 to January 24, 1890, 176 pounds of grain, 135 pounds of hay, and 39 pounds of smut were fed and 366 pounds of water given. When the experiment was begun December 13, 1889, the steer weighed 560 pounds. January 2, 1890, he weighed 551 pounds, and January 24, 555 pounds. No evidence of disease was discovered.

A LETTER OF INQUIRY AND A SUMMARY OF THE REPLIES.

The absence of reliable data concerning the nature, distribution, and importance of this disease led to the issuing of a circular letter in 1891 to a large number of farmers and cattle raisers by Dr. D. E. Salmon, Chief of the Bureau, for the purpose of obtaining more extended information concerning this disease. Although the replies to the various questions in this letter can not be considered from a scientific point of view altogether accurate, they were given in good faith and indicate the ideas then entertained by interested parties concerning the nature of this disease. During the past few years, however, the "germ theory," as announced by Billings, has become better known through the publication of his results and is more generally accepted as the correct explanation of this mysterious disease. Furthermore, the replies received are important in showing the economic importance attached to this disease by those who suffer most from its ravages. The letter and a summary of the replies are appended:

WASHINGTON, D. C., *March 20, 1891.*

SPECIAL CORRESPONDENT OF THE BUREAU OF ANIMAL INDUSTRY, DEPARTMENT OF AGRICULTURE.

SIR: For many years cattle feeders and stockmen have recognized a disease which has caused extensive losses among their cattle in the fall of the year when the animals were turned into cornfields to feed upon stalks.

Various causes have been assigned for the trouble, such as smut, indigestion from the hard, woody nature of the stalks, and lack of nutriment in the leaves, lack of salt, insufficient supply of water, and a germ producing the so-called "cornstalk disease."

This Bureau contemplates entering upon an investigation into the nature of the malady, but before commencing the critical examination, for which material can not,

be secured until next fall, we wish to collect information concerning the prevalence, symptoms, and other facts relating to the disease.

Accordingly this circular letter has been addressed to you as a special correspondent of the Bureau of Animal Industry with the hope that your experience will be a valuable aid to us in the investigation.

If those receiving this circular will promptly and as accurately as possible answer the questions on the opposite page they will confer a favor on the Bureau and assist in collecting information which may prove of great importance to the cattle industry of the United States.

A return envelope is inclosed, which can be used without the payment of postage.

Very respectfully,

D. E. SALMON, *Chief of Bureau*.

QUESTIONS.

(1) Have you or your neighbors ever lost cattle from turning them into cornstalk fields?

(2) How many cattle were turned into the fields and how many died?

(3) How were cattle fed before being turned into the cornstalk fields?

(4) How soon after they were turned into the stalk fields did any of the cattle die?

(5) How long before deaths ceased?

(6) What were the general symptoms of the disease?

(7) Did stock receive a liberal supply of salt and pure water?

(8) Did they receive any food in addition to the cornstalks?

(9) Have you noticed that some fields in the same neighborhood are more dangerous than others at the same time of year? If so, was there anything in the situation of the field or condition of the stalks to account for it?

(10) Have you observed any disease of the cornstalks in the fields where the cattle disease was contracted?

(11) Have any horses or other animals died from turning them into cornstalk fields?

(12) Is the disease becoming more frequent than formerly, or is it disappearing?

(13) Do you take any precautions for preventing the disease? If so, what are they, and what is your success?

There were received from the States of Indiana, Illinois, Iowa, Nebraska, Kansas, and Missouri a total of 634 replies to this letter, in which some or all of the questions were answered. Of these, 394 reported that either they or their neighbors lost cattle in cornstalk fields the preceding year. Sixty of these correspondents reported the disease in horses, and curiously enough 32 of them resided in the State of Kansas. Eight reported it in sheep, and 6 of these were from Kansas. The disease was not reported to occur in other animals.

A perusal of the replies to question 3 shows that the great majority of the affected cattle were on pasture land prior to turning them into the cornstalk fields.

The time that elapsed after turning the cattle into the cornstalks until death occurred is reported to be from four hours to two months. Of the 328 answers to the fourth question, 48 of them stated that death occurred in twenty-four hours; 59 in two days; 45 in three days; 23 in four days; 20 in five days; 13 in six days; 47 in seven days; 51 in from one to two weeks; 15 in three weeks; 5 in one month, and 5 in from one to two months. A few others indicated its occurrence in from four to eight hours.

The symptoms given were very numerous. Indigestion, bloating, constipation, "crazy," "stupid," and "dry murrain" were stated to be indications of the presence of the disease.

Fourteen outbreaks were reported to have occurred among cattle which were supplied with salt but no water; 35 outbreaks occurred where there was plenty of water but no salt. In 254 of the outbreaks reported there was an abundant supply of both water and salt, and in 123 outbreaks the cattle received neither salt nor water.

In answer to the question concerning food other than the cornstalks, 302 people replied that no other food was given, while 107 owners fed hay, straw, grain, or allowed the cattle to run at will in pasture or meadow land (usually meadow). The reply to this question was omitted in over 200 of the returned letters.

To the ninth question the answers were equally divided between yes and no. Some men stated that low ground was most dangerous, others that the disease occurred upon high ground most frequently. The presence of smut (*Ustilago maidis*) was the only abnormal condition of the cornstalks reported and was indicated in about one-third of the fields where the disease occurred.

The answers to the question whether the disease is becoming more frequent than formerly, or is disappearing, are interesting. Of those who replied to this question 115 stated that it was common, 50 stated that it was on the increase, while 264 wrote that it was decreasing, and a few others stated that there was no such disease.

Numerous methods for preventing the disease were indicated. Furnishing the animals with an abundance of salt and water and allowing them to remain in the stalk fields for only a short time each day during the first few days appear, however, to be the most common preventive methods. The removal of smut comes next. The fact that the disease appeared where these precautions were taken eliminates the desirability of considering them further than to point out the fact that thus far no efficient means of prevention has been adopted. A few of the customary preventive measures will be considered in connection with the outbreaks investigated.

SPECIAL INVESTIGATIONS.

METHODS.

The investigation into the nature and cause of this disease was attended with many difficulties. The facts that the disease appears at irregular intervals over a large territory, that there is no certainty of its appearing or recurring in any particular locality, that the affected animals are usually found dead, and that frequently all the deaths in an outbreak occur in a single day rendered the adoption of a method for procuring suitable material a matter of considerable difficulty. From the existing knowledge of the disease it was evident that laboratory work was quite as essential as post-mortems for the success of the investigation. The conditions mentioned rendered necessary the adoption of some plan whereby notice of the occurrence of the disease could be received promptly and the affected herd visited in the shortest possible time. A careful consideration of these and other conditions necessary for this investigation led to the conclusion that some place within the infected district should be selected where the necessary laboratory facilities could be obtained, and from which it would be possible to reach the affected animals before it would be too late to make the desired observations.

In carrying out this plan arrangements were made with the authorities of the State experiment station at Ames, Iowa, whereby the use of their bacteriological laboratory was obtained. Further assistance was afforded by the cooperation of Drs. Stalker and Niles, of the veterinary department. Dr. Niles assisted in many of the post-mortems and in the laboratory work. Through the kindness of Professor Wilson, director of the station, a notice of the intended investigations was inserted in nearly all of the county papers and all of the agricultural journals of Iowa, requesting that notice of all outbreaks of this disease should be promptly sent to the State experiment station. About one hundred letters were also sent by the chief of the Bureau of Animal Industry to cattle raisers who had replied to the circular letter of the year before, asking them to report promptly any outbreak of cornstalk disease in their locality, as steps were being taken to inquire into its cause and means of prevention. Through these arrangements it seemed highly probable that the opportunity would be given, in view of the extensive losses previously reported, to make careful observations on a considerable number of affected animals both before and after death.

Notwithstanding these preparations, it was found to be impossible to receive notice of the appearance of the disease and to reach the infected herd before the disease was over and the dead animals in several instances advanced in post-mortem changes. The disease usually occurred from 100 to 300 miles from Ames, and as word was not sent until one or more deaths had occurred, and then by mail, it is evident that with the utmost promptness from one to four days must elapse after the time of the first death until the examination was made. It is a significant fact that in 1892–93 only one outbreak occurred near Ames, and in this instance one of the two animals that died was found dead and the other was sick but two hours. However, several outbreaks were visited, and post-mortem examinations were made on a number of animals within a few hours after death.

The method of investigation followed in 1892 was to make careful post-mortem examinations, to make a large number of cultures from the different organs of all the animals that were in a suitable condition, to preserve in alcohol or Müller's fluid pieces of the tissue for microscopic examination, and to take to the laboratory at Ames large pieces of the organs for microscopic study while they were in fresh condition, and for additional cultures when deemed advisable. A large number of cover-glass preparations from the blood[1] and various organs were also made at the post-mortem, and subsequently stained and examined microscopically.

In 1893 Dr. F. L. Kilborne investigated several outbreaks of the disease in Iowa. He made the post-mortems, and sent cultures and tissues to the laboratory of the Bureau, where they were carefully examined. Although this method was attended with many disadvantages, it was in a measure quite satisfactory.

From the symptoms of this disease reported in 1892, the possibility of its being an affection of the nervous system resembling rabies to a certain extent was suggested. This theory was strengthened by the existence of a disease among cattle at Green, Iowa, in the fall of 1892, which could not be differentiated from rabies by the symptoms manifested or by rabbit inoculations, and in which a history of a dog bite could not be obtained. (See page 71.) The determination of this point by rabbit inoculations, the repetition of the bacteriological work, and the carrying out of certain feeding experiments for the purpose of testing the extent of the infection in the cornfields where the disease occurred were the lines of investigation followed in 1893.

The absence of recorded data on this disease has led to a somewhat detailed account of the conditions under which the various outbreaks occurred, and the appearances found upon post-mortem examination of certain of the animals. In the history of the outbreaks, as well as all facts relating to the individual animals prior to the post-mortem examinations, we must rely necessarily upon the statements of the owners who were carefully questioned concerning them.

OUTBREAK NO. 1.

This outbreak occurred on the farm of Mr. John Bixler, located about 3 miles west of Red Oak, Iowa. Mr. Bixler had about 70 animals (calves, cows, and steers) which had pastured on prairie land during the summer. About the 1st of November the cattle were turned into cornstalk and clover fields (20 acres of each). For the first six days they were allowed to remain daily in these fields one and one-half hours in the morning and the same time during the afternoon. After six days they were allowed to run in the cornstalk field, meadow, and pasture at will. It was observed, however, that they remained almost entirely in the cornstalk and clover fields. All the fields were on upland. The cattle had plenty of salt and well water.

November 11 the cattle were yarded for dehorning purposes, and each animal was noticed. They all appeared to be well. On the following morning a 2-year-old steer was found lying in a natural position, excepting the head which rested on the ground and moved continually from side to side. He could not be induced to get up. The frost on the grass showed that he had not floundered about. He remained in this position throughout the day and died early in the night.

---

[1] In addition to these, fresh preparations of blood were made and sealed, so that they could be examined microscopically before drying. It was found that white wax could be used with much success in sealing these mounts. Blood could be kept fresh for from eighteen to thirty hours by this plan.

November 14, the cattle were driven to water about 11 o'clock in the morning. A 2-year-old steer was observed to tarry behind the others. At 3 o'clock he was found lying in a dying condition. He was very much bloated, and died without struggling. No other cattle died, although they continued to run in the same fields. Notice of this outbreak was not received for three days after the last death had occurred. Owing to the fact that the animals had been skinned immediately after death, and that the temperature had been below freezing, the post-mortem changes were not so far advanced as would ordinarily be expected. They were examined November 18.

NO. 1 (STEER 2 YEARS OLD).

This animal had been dead five days and was much bloated. Brain appeared to be normal; no evidence of congestion. There was a slight pigmentation of the pia[1] over the frontal lobes. First and second stomachs were normal. Third stomach very hard; could be dented with the thumb only with difficulty; contents very dry; mucosa sloughed off (probably due to post-mortem changes). The mucosa of the true stomach deeply reddened in places, apparently due to blood extravasation. The mucosa of the duodenum and upper jejunum reddened, sprinkled with hemorrhagic areas, and covered with a muco-purulent substance. The edges of the folds of the mucosa in the cæcum and colon also reddened. Rectum appeared to be normal. Liver, spleen, and kidneys discolored and soft, due largely to decomposition. Lymphatics normal. No hepatization of the lungs.

NO. 2 (STEER 2 YEARS OLD).

This animal had been dead nearly four days. He was bled while in a dying condition, and consequently the post-mortem changes were less advanced than in No. 1. The brain was pale; small amount of pigment over frontal lobes. The third stomach was firm; contents dry. The fourth stomach and intestines showed more intense congestion than in No. 1; no hemorrhages. Gall bladder contained considerable thick, viscid, greenish-yellow bile. Kidneys pale. Spleen and lymphatics appeared to be normal. Liver reddened; edges rounded. Lungs not diseased.

Bacteriological examination.—Cultures were made from steer No. 2 only. Tubes of agar were inoculated with pieces of the brain, liver, and kidney. The tubes inoculated from the kidney remained clear. The others developed into pure cultures of *Bacillus coli communis.* A rabbit inoculated subcutaneously with 0.5 c. c. of a bouillon culture remained well. This organism was studied carefully, but found to possess no properties unusual for the colon bacillus.

Cover-glass preparations were made from the various organs at the autopsy. Those made from the kidney and liver contained putrefactive bacteria. In other preparations no bacteria were discovered.

Microscopic examination.—No microscopic examination was made of the organs from No. 1. The brain, liver, and kidneys in No. 2, examined in a fresh condition, showed advanced post-mortem changes. There was an abnormal amount of blood in the liver, cell nuclei visible, cellular protoplasm granular. Epithelium of the kidneys granular. Stained sections of the liver from pieces hardened in alcohol exhibited a granular condition of the cells; the nuclei were broken up but their outline was unchanged. There were few free nuclei. In areas involving a variable number of lobules the intralobular capillaries were distended with blood, the liver cells being separated from each other. The blood engorgement was more intense in the inner zones of the lobules. In similar sections of the kidney a few of the capillaries were distended with blood. Epithelium granular (probably due to post-mortem changes).

---

[1] This pigmentation is not uncommon in healthy cattle, as determined by the examination of the brains of a large number of animals slaughtered for beef.

In sections of both liver and kidney stained with aniline dyes a few putrefactive bacteria were observed.

OUTBREAK NO. 2.

Mr. E. E. Francis, residing near Wales, Iowa, lost one heifer in a cornstalk field. October 29 Mr. Francis turned 56 cattle in a cornstalk field for about two hours, when they were returned to the pasture. Thereafter the cattle were in the field continuously, and although they had access to a meadow they were observed to remain in the cornstalks most of the time. The corn was on upland. There was an unusually small amount of smut. The cattle had plenty of salt and well water. November 1, three days after the animals were turned into the cornstalk field, a heifer appeared to be dull, and the next morning she was found dead. She was examined by Mr. Francis, who found the rumen full and quite hard. No other lesions were noticed by him. The remaining cattle continued to run in the cornstalk field, but no other deaths occurred.

OUTBREAK NO. 3.

This outbreak occurred on a farm worked by Mr. L. W. Williams, located 3½ miles from Ames, Iowa. Mr. Williams had 13 acres of corn. It was on upland with the exception of a low, tile-drained area of about one-fourth acre which was said to have been wet during the spring and early summer. On this area the corn was small, but was said to have had a good color. The corn throughout the field was thin (few stalks in each hill) and the stalks large. There was very little smut.

November 22, Mr. Williams turned seven cattle, all in good condition, into the cornstalk field. The herd was composed of two cows, one 3-year-old and four 2-year-old heifers. The cattle were left in the field all day, but yarded at night without food. They had plenty of well water, but no salt until November 26. For the first two days they had access to a millet field, after which they had no food other than the cornstalks. Prior to turning the cattle into this field they had been in a clover meadow. The animals did well and no ill effect was observed until November 27, when a 2-year-old heifer was found dead.

November 29, the 3-year-old heifer was apparently well at 5.30 a. m. About 7 o'clock she was found resting squarely on her knees, the head extended and resting on the ground. She was frothing at the mouth and groaning as if in great distress. Mr. Williams said that blood oozed from the anus and vagina before death. She did not get up, dying about 9 a. m., two hours after she was first observed to be sick. The autopsies were made on both animals in the afternoon conjointly with Drs. Kilborne and Niles.

The remaining animals were kept out of the cornfield for a few days, after which they were returned without further loss. Mr. Williams had never before lost cattle with this disease, and so far as could be learned no other animals had died in that neighborhood while feeding in cornstalk fields.

Hogs which fed on the carcasses of the dead animals remained well.

No. 3 (A 2-YEAR-OLD HEIFER).

This animal was found dead November 27; examined in the afternoon of November 28. The post-mortem changes were considerably advanced. The spleen was slightly enlarged; a blood clot between the spleen and the rumen extended over an area 4 by 6 inches in diameter. The stomach and intestines throughout appeared to be normal. No impaction of the third stomach. Fibrous tufts on the ental surface of the omentum reddened from capillary injection. Liver discolored by post-mortem changes; no hemorrhages observable. About 100 c.c. of clear, viscid, reddish-colored bile in the gall bladder. A few punctiform hemorrhages beneath the capsule of the kidney; the blood vessels of the cortex slightly injected. The bladder was empty. Lymphatic glands contained a few small hemorrhages. Lungs normal. Punctiform hemorrhages beneath the epicardium over both ventricles. No blood extravasations detected beneath the endocardium. Several hemorrhagic areas along the aorta. The brain was normal in color and consistency.

Bacteriological examination.—A tube of agar and one of bouillon were inoculated with small pieces of the liver, and a tube of agar was inoculated from the kidney. The tube inoculated with the kidney remained clear. Those inoculated with the liver developed into pure cultures of a micrococcus. It possessed no pathogenic properties as determined by rabbit inoculations.

Cover-glass preparations were made from the liver, spleen, kidneys, and blood. Those made from the spleen showed, when properly stained, putrefactive bacteria. No bacteria could be detected in the others.

Microscopic examination.—The changes that had taken place in the tissues after death were so well marked that examinations were made of the kidney and liver only in the fresh condition. The parenchymatous tissue was granular, nuclei not distinct. In sections cut by the paraffin method the kidney exhibited no well-marked abnormal change. The nuclei of the tubular epithelium were quite distinct, but the cells were slightly swollen, and their free surfaces somewhat broken; the outline remained intact. The intralobular blood spaces were filled with blood.

No. 4 (A 3-YEAR OLD HEIFER).

The examination was made about four hours after death. The animal had been skinned, but the internal organs were not cold. Considerably bloated, said to be post-mortem.

The spleen was enlarged to fully twice its normal size. Hemorrhage between capsule and peritoneum extending over irregular areas, covering about one-third of the entire ental surface of the organ; pulp soft and of a uniform deep-red color; malpighian bodies were visible.

There was considerable light straw-colored œdema about the peritoneal attachments of the liver, the adjacent coils of the duodenum, and the gall bladder. The liver was much enlarged; edges rounded. The entire surface was mottled with purplish-black hemorrhagic areas varying from 1 to 10 mm. in diameter; frequently they were confluent. The intervening area was of a deep reddish color mottled with hemorrhagic infarcts varying from 1 to 6 mm. in diameter. Acini indistinct; parenchyma easily broken down. About 200 c. c. of a clear, not viscid, greenish-yellow bile. Beneath the mucosa of the gall bladder were several small areas of blood extravasation.

The kidneys were slightly enlarged; beneath the capsule there were a considerable number of punctiform hemorrhages. Capsule normal. Cortex thickened and the blood vessels injected; medullary portion apparently normal. Considerable hemorrhage between the kidney tissue proper and the connective tissue of the pelvis.

The contents and conditions of the mucosa of the rumen and recticulum normal. The contents of the omasum unusually soft. Mucosa normal. The mucosa over a few of the folds of the abomasum congested, otherwise normal. In the duodenum extending from the stomach for a distance of 3 to 4 feet the mucosa was sprinkled with punctiform hemorrhages, likewise similar areas in the jejunum. In the ileum and cæcum were several areas of congestion. Colon and rectum normal. Small blood clots in the uterus. Bladder empty. The mesenteric glands have hemorrhagic areas usually in the cortex, but in a few the medullary portion was involved. Lungs normal.

Heart of normal size. The blood vessels of the epicardium injected and blood extravasations along the course of the vessels which give the heart muscle a reddish (bloody) appearance. In the adventitia of the aorta were a large number of blood extravasations. These extended at irregular intervals from the heart to the diaphragm. The extravasations were more numerous over the auricles, beneath the endocardium, a large number of blood extravasations varying from mere points to areas a centimeter in diameter, many of them confluent. In the right ventricle extravasations covered about four-fifths of the entire surface. In the left ventricle a considerable area of its endocardium and auricle was hemorrhagic. Upon section the heart muscle of the right ventricle was found to be hemorrhagic for nearly one-third of its thickness, and in a few areas it extended entirely through the ventricular wall. A considerable number of blood extravasations in the muscles of the left ventricle. Several areas of the endocardium were of a grayish color. The blood in the heart and aorta was dark and firmly clotted.

Considerable hemorrhage was found over about four-fifths of the surface of the cerebellum and extending down between the cerebellum and cerebrum. The blood was between the pia and the brain substance. The blood vessels over the cerebrum were deeply injected; no hemorrhage. On section blood oozed from the cut ends of the smaller blood vessels.

Bacteriological examination.—Tubes of agar and those of either bouillon or glycerin-agar were inoculated, at the time of the examination, from the blood, brain, liver, spleen, kidney, and heart muscle. Large pieces of the various organs were taken to the laboratory in sterilized jars. From these, duplicate cultures were made on the following morning.

The cultures made from the liver, spleen, kidney, and one or more of those made from each of the other organs remained clear for several weeks, during which time they were shipped from Ames, Iowa, to Washington, D. C. Subsequently a few of them developed cultures of various species of saprophytic bacteria. The tubes of agar inoculated with the heart muscle, the blood, and brain developed into cultures of various bacteria within three days. The culture from the blood was impure. By means of agar plates two bacilli were isolated and subsequently carefully studied. They possessed no pathogenic properties and resembled in their cultural characters ordinarily observed saprophytic organisms. The agar tube inoculated with the heart muscle contained a pure culture of a nonpathogenic motile bacillus. The agar culture from the brain contained a streptococcus.

The agar culture from the kidney developed after several weeks into a pure culture of a motile bacillus. It was carefully studied, but found to be of no pathogenic importance as far as could be determined by inoculations into experimental animals.

A large number of cover-glass preparations were made from each of the organs and subsequently stained by various methods for the purpose of demonstrating bacteria, but with negative results. The subsequent examination of sections of the various tissues preserved in alcohol and stained for bacteria gave similar results.

Microscopic examination.—Sections and teased preparations of all of the organs of this animal were examined in a fresh condition. The nearness of the animal to the laboratory rendered this examination unusually favorable. The lesions discovered, however, were very slight. The liver cells were usually somewhat granular, and surrounded by a large number of red blood corpuscles, which filled the intralobular blood spaces. The nuclei were visible but broken up, giving to each the appearance of an area more or less thickly sprinkled with deeply stained points. Changes could not be detected in the interlobular tissue. The spleen, lymphatics, and brain did not show abnormal changes in the cellular elements. The blood was very carefully examined in fresh preparations. The corpuscles appeared to be normal. In the stained sections of the organs preserved in alcohol and Müller's fluid and cut by the paraffin method the engorgement and rupture of the blood vessels (capillaries) was more distinct. In the liver and heart muscle this was especially well marked. In the liver the blood engorgement was intense in the central zone of the lobule. The outlines of the nuclei were not altered. In certain limited areas free nuclei were observed.

The parenchyma of the kidneys appeared to be normal. In certain limited areas the capillaries were distended with blood.

In the heart muscle the capillaries were injected about the hemorrhagic areas. The normal markings of the heart muscle in the thin areas were not effaced, the lesions being confined to the capillaries.

OUTBREAK NO. 4.

This outbreak occurred on the farm of Mr. S. P. Miller, who resided about 5 miles northeast of Red Oak. Mr. Miller had 14 acres of corn, all on high land. The corn was good, but there was considerable smut.

Mr. Miller stated that on November 15 he turned 24 cattle, mostly calves 4 to 7 months old, into the cornstalk field. For several weeks prior to this they had been on clover pasture. For the first three days the cattle were allowed to remain in the cornstalks for about three hours daily. They received salt once a week and were supplied with plenty of fresh well water. They were allowed to run at will in a clover meadow adjoining the cornstalk field and appeared to do well for eight days when they began to die.

November 23, eight days after the cattle were turned into the cornstalk field a calf was found dead and much bloated, with froth about the mouth and nose.

November 24, a yearling was found dead. It had taken water twice and appeared perfectly well the day before.

November 26, a calf was found unable to get up. It appeared to be stiff and could move only with difficulty. It appeared to suffer very much; head down and eyes rolled up. It kicked considerably, and was shot in the afternoon to relieve its suffering.

November 29, a calf was found sick in the morning. It appeared to be "crazy," butted its head against boxes, and made desperate efforts to get out of the barn. It laid down in the forenoon and could not get up. A part of the time it remained quiet, but at times it kicked and bellowed as if in great distress. In the afternoon there was a normal passage of the bowels. It ate nothing. At night it was killed by a blow on the head to relieve its suffering.

After the death of the fourth animal the remaining cattle were taken out of the cornstalk field and turned into a similar field on the opposite side of the road, where they remained well. Several horses were left in the infected field, none of which took the disease. Word was received of this outbreak at Ames November 28. November 30 we made an examination of these animals, but owing to warm weather the post-mortem changes were too far advanced in all but the last to make examinations of any value except to determine that the lungs were not hepatized.

No. 5 (A Calf 7 months old).

It had been dead about fourteen hours and was considerably bloated, but in good condition. The post-mortem changes were slight. The capsule of the spleen was apparently slightly thickened; pulp soft. The capsules and size of the kidneys were normal; cortex reddened, due to injection of blood vessels. Considerable blood escaped from the small vessels on section. About 750 c. c. of cloudy urine in the bladder. Liver of normal size. Centers of the acini of a deep reddish color; periphery pale. Considerable blood escaped on section. Interlobular tissue apparently normal. About 100 c. c. of clear, dark, viscid bile in gall bladder. Contents and mucosa of the first, second, and third stomachs normal. The contents of the omasum dry, but not impacted. The blood vessels in the duodenum were injected in areas for a distance of about 4 feet. Mucosa of the ileum deeply reddened; contents normal. In the mucosa of the cæcum, colon, and rectum were areas in which the blood vessels were deeply injected; contents normal. Lymphatics normal. Heart and lungs normal. Brain not examined on account of injury produced in killing the animal.

Bacteriological examination.—Tubes of agar were inoculated with small pieces of the liver, spleen, and kidney, and with several loops of the heart blood. About 20 c. c. of the blood were taken from the heart by means of a sterile pipette and transferred to a sterile cotton-plugged tube. It remained sterile. The tubes of agar inoculated with the spleen developed into pure cultures of a motile bacillus. One of the tubes inoculated with the blood developed into a pure culture of a motile bacillus belonging to another species. These bacilli were carefully studied and found to produce no pathogenic effect on rabbits. The other tubes of media inoculated from this animal remained clear.

A large number of cover-glass preparations from the different organs and blood were made. They were carefully stained and examined, but no bacteria or other microorganisms were discovered. The same results were obtained from sections of the kidney and liver stained for bacteria.

Microscopic examination.—Before it was possible to reach the laboratory the tissues taken from this case were too much decomposed for examination. The sections of the kidney and liver from pieces of those organs preserved in alcohol and Müller's fluid were carefully stained and examined. The kidney showed a slight injection of the capillaries in circumscribed areas. The liver showed in certain areas extensive engorgement of the intralobular blood spaces. In these spaces were a few free nuclei, and the liver cells were separated from each other. No appreciable change of the interlobular connective tissue. The spleen appeared to be normal.

OUTBREAK NO. 5.

This outbreak occurred on the farm of Mr. C. Johnson, of Tyner. He had two fields of corn. One of them contained 10 acres of upland and 2 acres of rather low, moist ground, and the other contained 45 acres of upland and 15 acres of low, wet ground. The corn on all the upland was very good; that on the lowland was "snapped" early in the fall and fed to cattle in the feed yard, all of which remained well.

October 31, 1892, Mr. Johnson turned 22 cattle into the 12-acre cornstalk field. Prior to this the cattle had been on pasture land. Before turning them into this field they were all dehorned. On the morning of November 1 a steer was found dead. The cause of death in this animal was attributed to the dehorning the night before, as the hemorrhage was extensive and the weather severe. No other deaths occurred while the cattle remained in this field.

November 19, the cattle were turned from the 12-acre field, together with 10 horses, into the 60-acre cornstalk field.

November 20, a 3-year-old heifer and a yearling steer were found dead. Both of these animals appeared well the night before.

November 25, two cows and two steers were found dead. One of the steers appeared to be "crazy and blind" the night before. The ground about the dead animals showed that they had rubbed their heads to and fro on the ground and that one of them had struggled considerably. Two of these animals were examined by a butcher, who stated that "the blood was a little dark, otherwise there was no disease." Mr. Johnson opened the heart and found dark colored clots of blood.

November 25 to 27, the remaining cattle were kept out of the cornstalk field.

November 28, they were allowed in the cornstalk field for about three hours.

November 29, they were in the cornstalk field all day.

November 30, a 3-year-old heifer which appeared to be well early in the morning was found lying down about 7 o'clock and unable to get up. She bellowed and kicked a great deal. When quiet, the legs were extended from the body and the tongue protruded from the mouth. She died two hours later.

Notice of this outbreak was received at the experiment station at Ames, December 1. In company with Dr. W. B. Niles I made a post-mortem examination on the dead animal (last to die), and carefully inspected the cornfield in the afternoon of the following day. Nothing was found to arouse suspicion. Arrangements were made with Mr. Johnson by which a feeding experiment in the infected field with other cattle could be made, but unforeseen incidents prevented the carrying out of this plan.

Mr. Johnson kept his cows out of this field for some days, when they were returned without further loss.

NO. 6 (A 3-YEAR-OLD HEIFER).

This animal was examined about thirty hours after death. The organs were badly decomposed. The normal markings were for the greater part entirely effaced. There was no evidence discernible of ante-mortem changes in any of the organs. The third stomach was rather soft; feces in the rectum of normal consistency. The lungs reddened; no hepatization. Brain normal in color, but quite soft.

There were 10 horses, all of which remained well, in the cornstalk field with the cattle. Hogs which fed upon the carcasses of the dead animals remained well. The facts that the "snapped" corn was fed to fattening cattle without producing any disturbance would indicate that the death of the animals was not due to feeding upon the few nubbins of corn that were inadvertently left in the field. It was observed by Mr. Johnson that the cattle fed largely on the cornstalks on the lowland.

A large bundle of the stalks, mostly leaves, was collected from the low ground and sent to the laboratory of the Bureau for a chemical analysis and for feeding rabbits. (See page 42.)

OUTBREAK NO. 6.

Mr. Robert Johnson, residing about 4 miles from Mechanicsville, lost two steers after turning them into a cornstalk field. A few others were sick, but recovered. The history of the outbreak, as given by Mr. Johnson, is as follows:

Thirty-seven cattle, a flock of sheep, and six horses were fed on cut cornstalks from about the 1st of October until the middle of November. At that time all of the animals were turned into a small (3-acre) cornstalk field. They had plenty of salt and well water. The stalks were soon devoured, after which the animals were fed on cut cornstalks and tame hay.

In about five days after the cattle were turned into the cornstalk field, but while they were still feeding upon the standing cornstalks, two steers were taken sick and died in four days.[1]

While sick the steers ate with difficulty, frothed at the mouth, appeared to have sore mouths and eyes, and lost flesh rapidly. They exhibited no "crazy" symptoms.

November 21 a carload of the cattle was shipped to Chicago. Upon inspection at the stock yards one of the animals was rejected on account of its being "gaunt," but was sold to other parties. Soon after this two yearlings and a cow that were purchased and turned in with the remaining cattle were taken sick. They manifested the same symptoms but to a less degree than those which had perished. When examined, December 3, they appeared to have fully recovered. The horses and sheep remained well.

---

[1] It is highly probable that these cattle died from some affection other than the cornstalk disease.

OUTBREAK NO. 7.

This outbreak occurred on a farm worked by Mr. Michael Cosgrove, located about 7 miles east of Toledo, Iowa. Word of this outbreak was not received until several days after the last animal had died, so that post-mortem examinations were not made. The following facts concerning the cattle were obtained from the owner:

The last of October, 21 cattle were turned into a cornstalk field. They remained well while in this field. November 18 they, together with 6 horses, were turned into a cornstalk field of 30 acres, mostly upland. They were in the field for only a few hours each day for the first five to eight days; the balance of the time they were on pasture land. They had plenty of salt, and well water was kept continually within their reach.

November 27 a cow was found down and unable to get up. She died during the following night. During the next forty-eight hours two other animals died, after an illness of about twelve hours each. Each of the affected animals appeared to be in much distress.

The horses remained well.

The crop of corn was good. There was considerable smut, all of which was picked and drawn out of the field when the corn was gathered. In 1891 four steers were said to have died of this disease while in the cornstalk field on the same ground. Mr. Cosgrove believed that the smut was the cause of the disease, and hence the precaution taken in 1892.

OUTBREAK NO. 8.

Mr. C. N. Heberlee, of Stewart, lost five cattle in cornstalk fields during the fall and early winter. The history of the outbreak, as given by Mr. Heberlee, is as follows:

About November 10, 1892, 25 cattle, mostly yearlings, were turned into a 15-acre cornstalk field. For the first few days they were in the cornstalks for only a few hours each day, but later they were left in them continuously.

November 25, the cattle were transferred to a 20-acre cornstalk field. Both of the fields were on upland. There was a moderate amount of smut on the corn. The cattle obtained water from a small stream which ran through an adjacent field (creek bottom). Rye had been sown in the cornfield, which gave a considerable amount of green food. The cattle had not been salted since they were turned into the cornstalks.

December 1, three steers were found dead. They were last seen November 29, when they appeared to be well. They were examined by Dr. Kilborne December 1, 1892. Owing to mild weather decomposition was well advanced, and little could be learned of the pathological changes. The contents of the third stomach were soft. The mucosa of the duodenum in each case contained areas of deep congestion. The lungs were not hepatized. All markings of the liver and kidneys were effaced.

December 2, another steer (No. 7) was found down and unable to get up. It groaned frequently and died about 10 a. m. Later in the day another steer (No. 8) was found dead. He had evidently been dead for sometime. Both of the animals were examined by Dr. Kilborne in the afternoon of December 2.

NO. 7 (A YEARLING STEER).

This animal had been dead but a few hours and was in good condition, not bloated. The spleen was not enlarged; pulp firm. On the ental surface there were about twenty deeply stained fibrous tufts, similar to those found on the omentum in cases of Texas fever. Malpighian bodies distinct. Liver swollen, deeply congested, giving it a dark-red color. On section the acini appeared with dark-red centers with lighter peripheries. Gall bladder contained about 100 c. c. of clear, viscid bile. The cortex of the kidneys was pale; medullary portion apparently normal. The mucosa of the bladder was sprinkled with punctiform hemorrhages. The bladder contained about 1,500 c. c. of clear urine, which was found to contain a small amount of albumin.

The first three stomachs were normal. The mucosa of the abomasum and areas in the duodenum and jejunum were congested. Ileum was filled with a pasty substance for about 8 feet from the lower end. The mucosa hemorrhagic. The membrane of the cæcum, colon, and rectum deeply congested. Contents rather dry. Lymphatics œdematous, not congested. Lungs normal. Numerous blood extravasations beneath the epicardium over both ventricles. A few hemorrhages beneath the endocardium in the right ventricle; in left ventricle a large hemorrhagic area. Heart empty. Small hemorrhagic points observed in the subcutaneous tissue, especially in the axilla and groins.

Bacteriological examination.—Cover-glass preparations were made from the blood, liver, kidney, and spleen. They showed no bacteria. Tubes of agar and bouillon were inoculated with pieces of the spleen and liver and remained clear.

Microscopic examination.—No examination was made of the fresh tissues. Pieces of the liver, spleen, kidney, and thigh muscles were preserved in Müller's fluid and alcohol. Sections of these organs cut by the paraffin method were carefully examined. Those of muscle and spleen showed no abnormal changes. A few of the capillaries in the cortex of the kidney were distended with blood. The tubular epithelium normal. The intralobular blood spaces in the liver were distended with blood. The engorgement was more general than in the previous cases. Liver cells separated and a few free nuclei. In many cells the nuclei presented small, deeply stained points separated by unstained portions. The outline of the nuclei not changed. There was considerable destruction of the liver cells in the central zone of some of the lobules.

NO. 8 (A YEARLING STEER).

This animal was bloated; post-mortem changes well advanced. Considerable straw-colored œdema in connective tissue surrounding gall bladder. Mucosa of the fourth stomach (abomasum) deeply congested. The mucosa of the intestines appeared to be normal. In other respects the lesions, so far as they could be determined, were not different from those in No. 7. On account of decomposition cultures were not made and none of the tissues preserved for microscopic examination.

OUTBREAK NO. 9.

Mr. John G. Jones, of Wales, lost three young animals in cornstalk fields in November. When visited the cattle had been dead for several days and consequently a post-mortem examination was not made. The data concerning the management of the cattle, as detailed by Mr. Jones, is as follows:

The first week in November, 40 head of cattle were turned into a 10-acre cornstalk field. They were allowed to remain in the cornstalks a few hours only each day for the first few days. They had access to a 20-acre clover meadow, and were yarded at night. They received salt twice a week and well water every night and morning. The corn in this and the subsequent field into which the cattle were turned was on high, rolling, prairie land. The growth of the corn was good. There was a small amount of smut. About November 16 the cattle were transferred to a second cornstalk field, which contained 20 acres, all on upland. While in this field they received no food other than cornstalks. They were yarded at night as before.

November 23, about 5 p. m., a steer was found to be sick. He stood apart from the others. About an hour later an effort was made to get him into a shed, when he fell down and could not be induced to get up. He remained quiet until about 8 p. m., when he died, three hours after he was first known to be sick.

November 24 the cattle were all apparently well when they were turned into the field at 9 a. m. At 2 p. m. a steer was found sick. It died in about two hours.

November 25 the cattle appeared to be well when yarded at night. The following morning (November 26) a yearling heifer was found unable to raise her head from the ground, apparently in a semicomatose condition. She remained in this condition until death occurred some hours later. None of the cattle bloated before death.

The remaining cattle were kept out of the cornstalks on November 27 and 28, but they were returned November 29. No death occurred subsequently.

Four years before (1888) Mr. Jones stated that he lost 4 or 5 animals in cornstalk fields, and about eight years prior to that he lost 8 animals from the same cause.

OUTBREAK NO. 10.

Mr. David G. Jones, who lived on a farm adjoining that of Mr. J. G. Jones (Outbreak No. 9), lost 2 animals in a cornstalk field. The absence of the owner rendered it impossible to obtain a complete history of this outbreak. As near as could be learned 15 cattle were turned into a cornstalk field about November 18. November 24 a 2-year-old steer died. November 30 a yearling steer died about 6 p. m. It was examined by Dr. Kilborne on the afternoon of December 1, about eighteen hours after death.

No. 9 (A YEARLING STEER).

The spleen was dark colored, not enlarged, pulp soft. The surface of the liver was mottled with irregular branching, yellowish areas. The same condition was found upon section. The remainder of the liver was of a deep reddish color; acini indistinct; gall bladder empty. The cortex of the kidney was congested; no blood extravasation. About 100 c. c. of apparently normal urine in the bladder.

The mucosa of the first and second stomachs was unusually dark; contents normal. Third stomach contents rather dry, but not impacted. The mucosa of the true stomach deeply congested. The mucosa and contents of the duodenum and jejunum normal. In the lower 3 feet of the ileum the contents were blood stained and the mucosa was deeply reddened, due to the injection of the capillaries; contents normal. Colon and rectum normal. There were extensive blood extravasations beneath the epicardium of both ventricles and beneath the endocardium in the left ventricle of the heart. A small number of ecchymoses in the right ventricle.

Bacteriological examination.—Owing to an accident, cultures were not made from this animal. Cover-glass preparations from the blood, spleen, liver, and kidneys showed no bacteria.

OUTBREAK NO. 11.

This outbreak occurred on the farm of Mr. Tubbs, located a few miles from Emerson. It was learned at Emerson that the cattle had been dead for several days. This fact, together with the presence of a severe storm and deep snow, prevented a visit to the affected herd. The more general facts concerning the condition under which the outbreak occurred and the extent of the loss sustained were obtained from Mr. Tubbs, sr., who resided at Emerson.

About November 24, 140 cattle were turned into a cornstalk field of 65 acres. December 2, eight days later, 10 2-year-old steers were found dead. They were not known to have been sick. The remaining 130 animals were removed to a meadow, where 3 others died the following day. No more deaths occurred. The cattle were not returned to this field. The corn was good and situated on upland. There was very little smut.

About twenty-two years before Mr. Tubbs, sr., lost 20 animals in cornstalk fields. He had observed that the disease was most prevalent during dry seasons, and that snow or rain checked the progress of the disease. This opinion was entertained by veterinarians in that vicinity.

Mr. Tubbs reported that a neighbor, Mr. W. K. Post, lost 4 animals out of a herd of 33 which were turned into a cornstalk field. The deaths occurred on the eighth and ninth days after the cattle were turned into the field. Six young horses were pastured in the field with the cattle. The horses and the remaining cattle were kept continually in the cornstalk field, but no other deaths occurred.

OUTBREAK NO. 12.

This outbreak occurred on the farm of Mr. C. W. Hunt, of Woodbine. Although Mr. Hunt was visited by Dr. Kilborne immediately after receiving notice of the presence of the disease among his cattle, it was found upon arrival that no deaths had occurred for several days. Mr. Hunt's account of the symptoms observed in the affected animals, together with his statement concerning the condition of cornstalks and his method of managing the cattle, are unusually interesting.

During the first week of November, 33 cattle were turned into a cornstalk field of 20 acres. For the first three days the cattle were in the cornstalks daily for two, three, and four hours, respectively. Afterwards they were in the field continuously. In about a week 2 steers were found dead. The remaining animals were left in the field until December 7, when they were transferred to a second cornstalk field. December 11 the same cattle were turned into a third cornstalk field containing 20 acres.

December 12 a steer was taken sick about 2 p. m. He laid down but could not get up. He remained quiet and was alive at dark, but was found dead on the morning of December 13, together with another steer which appeared to be well the night before.

December 13 a steer was observed to stop very suddenly and begin to tremble; muscles twitched and jerked. It soon laid down, and died in about an hour.

The symptoms generally appeared to Mr. Hunt to resemble those produced in a dog by an overdose of strychnine.

The cornfields were on high ground and all the corn was good. In the first two fields there was considerable smut and in the third a very large quantity. The cattle were watered from a running stream that passed through the place.

Mr. Beebe, a neighbor of Mr. Hunt, stated that he had lost three cattle in a cornstalk field. They died in about one week after being turned into the cornstalks.

OUTBREAK NO. 13.[1]

This outbreak occurred near Van Meter, Iowa. Mr. A. B. McCleary purchased the standing cornstalks in two adjacent cornfields, containing 25 and 20 acres, respectively. They were on high ground. October 27, Mr. McCleary turned 35 cattle, mostly 2-year-old steers, into the 25-acre field. The cattle had free access to salt, which was kept continuously in an adjacent yard. They obtained drinking water from a small stream which passed along one side of these fields. The cattle were allowed to remain in the field continuously until November 26, when they were turned into the adjacent field. They also had free access to the first field, and obtained salt and water as before. The growth of the corn was much better in the second field than in the first. The soil was apparently identical, and the difference in the growth of the corn was attributed to the effect of the previous crops. In the first field the corn crop was preceded by oats and in the second field by clover meadow. There was a moderate amount of smut on the corn in both fields.

November 28, two days after the cattle were turned into the second field, a steer was found dead.

Early in the morning of November 29, 2 steers were found lying down and unable to rise. About 11 a. m., 2 others were found to be sick, and in a short time were unable to stand. One of the first affected was found dead at noon. The other 3 died before 2 p. m. Between 11 a. m. and 12 m. Mr. McCleary transferred the remaining 30 steers to the stock yard of his father, about 1 mile distant. About 1 p. m. the sixth steer was taken sick in the stock yard and died in about six hours. At 5 p. m. a seventh steer (No. 10 examined) was taken sick and died within two hours.

---

[1] The field notes on this and subsequent outbreaks were made by Dr. F. L. Kilborne in the fall of 1893.

November 30 a steer (No. 11 examined) was found dead at 5 p. m., and it had evidently been dead but a short time. It was apparently as well as usual at 11 o'clock the night before.

Five colts, 2 and 3 years old, were in the cornstalk field with the cattle, but they remained well and were left in the field for three or four weeks after the cattle were removed.

The symptoms were closely observed in this outbreak by Mr. McCleary, his father, and two brothers, and also by a local veterinary practitioner.

The affected animals were quiet and stood with the head down. If forced to move they walked with jerky movements, especially of the hind limbs. In one case a steer showed a marked desire to press his head against the side of the stable, where he stood until he fell and was unable to rise.

Soon after the attack the animals showed marked weakness, especially in the knees, causing them to stagger if they tried to walk. After a variable time they would fall on their knees, shake the head, and either rise with some difficulty or fall completely down. Often two or three efforts to rise would be required before succeeding.

Following the first symptoms of weakness, they shivered or trembled "as if suffering from a chill." They were not feverish to the touch. Dribbling of the urine occurred while the animals were staggering about just before falling.

After falling down and getting up a few times they would fall on one side, unable to rise, and stretch out at full length, with the head thrown backward. Respiration was accompanied by "groans," as if the animals were in great distress. More or less saliva escaped from the mouth after the animals fell. The limbs and head, but especially the former, moved continuously backward and forward. No excitement or other nervous symptoms were noticed in this herd. The animals began to bloat soon after death.

The most reliable account of a recovery which we have from an attack of the cornstalk disease occurred in this outbreak. A steer was taken sick about 2 p. m., November 29, with the same symptoms as those manifested by the animals which died. He had difficulty in walking and trembled violently for a short time, when he fell. After ten or fifteen minutes he succeeded in getting up. He staggered about for a short time, when he began to improve and made a rapid recovery.

November 30, post-mortem examinations were made on two of these animals.

No. 10 (A 2-YEAR-OLD STEER).

This animal had been dead for about twelve hours when examined. Post-mortem changes were well marked. The rumen was distended with gas. Spleen considerably engorged, the pulp soft, and the normal markings were barely visible. There was considerable blood extravasation beneath the capsule.

Liver congested; surface, especially around the border, mottled with deep-red points. The acini, especially as seen on section, were distinct; the central portion exhibited a dark-red color; the peripheral portion was quite pale. Bile of a dark-greenish color and normal consistency. Kidneys apparently normal; urine cloudy. The first three stomachs normal in appearance. In the true stomach the mucosa was hyperæmic and sprinkled with numerous petechiæ. Intestines apparently normal. Lungs normal. Numerous points of blood extravasation beneath the epicardium. A few ecchymoses beneath endocardium of both ventricles. Both ventricles were filled with blood clots. Brain somewhat softened, otherwise normal.

Bacteriological examination.—Tubes of agar and glycerin agar were inoculated with pieces of the spleen, liver, kidney, brain, and several loops of the blood. The tubes of glycerin agar inoculated with the spleen and blood, and the agar tube inoculated with the liver developed into pure cultures of a micrococcus. The other tubes that were inoculated from this animal remained clear. The micrococcus was found to possess no pathogenic properties as indicated by intravenous inoculation of a large quantity of a pure culture into a rabbit.

Cover-glass preparations were made from the different organs and tissues at the autopsy. They did not reveal the presence of any bacteria. The same is true of sections of the organs preserved in alcohol.

The brain was placed in pure glycerin and shipped by express to the laboratory, where it was received three days later. Several rabbits were inoculated beneath the dura with from one to three drops of a suspension of the brain substance in sterilized distilled water. The inoculation wound healed rapidly and the rabbits remained well.

No. 11 (A 2-YEAR-OLD STEER).

This animal had been dead about thirty hours and had already been opened by Mr. McCleary and the intestines and stomach removed. The decomposition was somewhat advanced. The liver was deeply congested and presented acini with dark centers and pale periphery, as in No. 10. The capsule of the spleen was dotted with several pyriform hemorrhages. Pulp very soft and almost black (probably post-mortem). Brain substance of normal consistency, a considerable quantity of semiclotted blood surrounding the cerebellum beneath pia. A few punctiform hemorrhages in meninges covering dorsal surface of the spinal cord in the cervical region.

OUTBREAK NO. 14.

Mr. A. N. Hadley, of New Providence, lost 15 animals in cornstalk fields. He had lived on the farm for seven years, but this was the first appearance of the disease. Unfortunately word of this outbreak was not received until several days after the last death occurred. The history of the outbreak, as learned from Mr. Hadley, is as follows:

October 25, 38 cattle, mostly 2-year-old steers, were turned into a 20-acre cornstalk field and allowed to remain there continuously. October 30, 7 of the steers were found dead and at 2 p. m. 3 more had died. On the following morning (October 31) another steer was found dead. The remaining cattle were turned from this field into a cattle yard and fed hay together with a little corn on the ear. After three or four days' stay in the yard they were turned into a second cornstalk field containing from 25 to 30 acres. At first they were kept in the field for from two to three hours daily, but after three days they were allowed to remain in the cornstalks during the day and were yarded at night.

November 15, the cattle were turned into a third field containing 20 acres, adjacent to the second one. As in the second field, they were allowed to remain in the cornstalks for only a few hours each day for the first few days. November 22, a steer was found dead in the morning and a second one died in the evening. The animals were known to have been sick for three or four hours. From November 23 to November 29, the remaining cattle were kept in a yard and fed as before. November 29, they were turned into field No. 4, which contained 35 acres, and were allowed to remain in this field continuously until December 7, without further loss.

December 2, 14 yearling steers were purchased and turned into the fourth field with the other cattle. December 7, all of the animals were turned back into field No. 3. There was from 6 to 8 inches of snow on the ground. December 9, two days after the cattle were turned into this field, two of the recently purchased yearlings were found lying on the ground unable to rise and died in a few hours. The death of these animals occurred in seven days after they were turned into field No. 4. After the death of these two animals the cattle were removed from the cornstalk fields.

The cornfields were on upland, excepting a narrow strip above a water course which passed through each field. In the first, third, and fourth fields the corn was good and the growth of stalks large, but in the second one the growth of the stalks was much smaller.

While in the first field the cattle had also the run of several acres of grass land from which a crop of hay had been removed. The first field was about a mile distant from the other three, which were adjacent to each other. There was only a small amount of smut in the first, second, and fourth fields, but in the third there was a much larger quantity. The cattle were salted irregularly while in the first field. Subsequently salt was constantly in the fields. While in the first field the cattle were supplied with water from a small stream which passed through it; in the other three fields they obtained water from a tank in an adjoining yard. Much of the corn from the first field had been "snapped" and was being fed to fattening cattle at the same time that the 35 animals were pasturing in the cornstalks. The "snapped" corn produced no ill effects.

A few symptoms were observed by Mr. Hadley. One of the animals (eighth to die) appeared to have a chill which lasted two hours before death. This animal, however, with several others, had broken into a neighbor's cornfield the day before, and the cause of death was evidently complicated with, if not due to, overengorgement with corn. This may explain the cause of the bloating.

OUTBREAK NO. 15.

This outbreak occurred on the farm of Mr. C. Keyser, of Percival. He had 80 acres of corn on "bottom" land, which had been under cultivation for many years and the stalk field was free from weeds. The corn was good. There was a moderate amount of smut.

November 26, 100 cattle, consisting of young cows (2 to 5 years old) and a few steers (2 to 3 years old), were turned into the cornstalk field and left there continuously. For a month prior to this they had been in another cornstalk field. December 2, 10 young cows were found dead. The remaining cattle were taken from the field, but after a day or two were returned. Twelve of these died during the next four days. The cattle were being watched when 3 or 4 of the cows were taken sick. They were reported either to move about strangely or stagger more or less for a few minutes, then fall down and die within an hour or two. December 4, 75 of the cattle were sold and shipped to Omaha.

Although the infected farm was visited as soon as possible after word of the appearance of the disease was received, the last animal to die had been dead for three days, and on account of advanced decomposition post-mortem examinations were not made.

OUTBREAK NO. 16.

This outbreak occurred on the farm of the French Community, near Corning. November 20, 75 cattle, consisting of 33 yearlings, 7 2-year-olds, and 35 cows, were turned into a cornstalk field for from ten to fourteen days. The yearlings remained in the field continuously, but the cows were yarded every night.

November 26, a 2-year-old heifer died. The other animals appeared to be well.

November 29, 7 yearlings were found dead. One yearling and a 2-year-old were sick. The yearling died in a few hours, but the 2-year-old recovered. None of the cows were affected.

About 60 acres of the corn were on upland and about 20 acres were on lowland. The cornfield on the upland and the one on the flats were separated by a considerable area of blue-grass pasture land, which was for the greater part on the flats. The corn was good. That on the lowland contained considerable smut, but there was very little on the upland. This was the fifth consecutive crop of corn on this land. The cattle had free access to a tank of water standing in the yard and supplied from a well by means of a windmill. The cattle were regularly salted every two or three days.

Mr. L. Brettanier, the herdsman for the community, observed the following symptoms in the first heifer to die: When first observed she was standing apart from the others "acting strangely;" her eyes had a wild or startled look, and at the same time she acted a little "crazy." In walking she would raise her hind feet with a peculiar jerky movement. She soon began to stagger, and after a few minutes laid down and was unable to rise. She continued to move her head and limbs back and forth until death ensued.

OUTBREAK NO. 17.

This outbreak occurred on the farm of Mr. John Sunderland, of Hastings. He had 70 acres of corn, all on upland. The corn yielded a good crop and there was a heavy growth of stalks. It was the second year that corn had been cultivated on this land. There was considerable smut this year, but in 1892 there was very little.

December 3, 70 head of cattle (35 yearlings and 2-year-olds and 35 from 3 to 5 years old) and 10 horses were turned into the cornstalk field.

December 7, 7 of the young cattle were found dead. No deaths occurred subsequently. The horses remained well.

In 1892, 15 of a considerable number of animals pasturing in the cornstalks on this same land died. As in 1893, they were all young cattle, the older animals being apparently exempt from the disease.

OUTBREAK NO. 18.

This outbreak occurred on the farm of Mr. E. M. Carey, of Red Oak. He had 40 acres of corn on river-bottom land. There was a heavy growth of stalks and the corn was good. Previous to this year clover and timothy had been raised on this ground. When the field was examined (December 17) very little smut could be found.

December 7, Mr. Carey turned 226 cattle (about half of which were yearlings) into the 40-acre cornstalk field where they were allowed to run in the field continuously.

December 10, a 2-year-old heifer died very suddenly.

December 14, 16 yearlings and one 2-year-old were found dead. All of these animals were apparently well when they were seen on the preceding morning by the foreman of the farm. No deaths occurred subsequently, although the cattle were left in this field for several days. The dead yearlings were about equally divided between the two sexes, and one of the other cattle was affected. The cattle obtained water from the river, and were not salted. The cornfield was free from grass, and the animals had no food other than the corn fodder.

December 17, an examination was made of the dead animals. The post-mortem changes were too far advanced in most of the cases to enable the identification of slight pathological changes. In one case, however, the organs were quite well preserved.

NO. 12 (A YEARLING STEER).

This animal died on the morning of December 14, and was examined early in the morning of December 17. Post-mortem changes not as advanced as would naturally be expected. The liver was congested. The acini were distinct; the central portion was of a bright reddish color. The bile was normal in appearance and quantity.

The spleen was not enlarged; there were several ecchymoses beneath the capsule. The kidneys and urine appeared to be normal. The intestinal tract appeared to be normal excepting the omasum, which was unusually firm, although not impacted. The lungs were normal. There were several petechiæ beneath the epicardium, and post-mortem clots in both ventricles.

The brain was considerably softened, otherwise apparently normal. In one other case the liver, spleen, and heart exhibited lesions similar to those in No. 12. Intestinal tract normal.

Bacteriological examination.—Cover-glass preparations were made from the different organs and subsequently examined for bacteria. They gave negative results. Tubes of agar were inoculated with pieces of the liver, spleen, kidney, heart blood, and brain. December 21, the inoculated tubes were all clear. December 28, one of the agar tubes inoculated from the blood had developed into a pure culture of a spore-bearing bacillus belonging to the *Bacillus subtilis* group of bacteria. All of the other inoculated tubes remained clear.

About 3 c. c. of the blood were drawn up into a sterilized pipette and sealed. A rabbit inoculated subcutaneously with about 2 c. c. of this blood remained well. Four rabbits inoculated beneath the dura with from one to three drops of a suspension of the brain in bouillon remained well.

CORNSTALKS AFFECTED WITH "CORN BLIGHT," OR THE BURRILL DISEASE ARE FREE FROM PATHOGENIC PROPERTIES.

The large number of bacteriological examinations of the organs of cattle which died in cornstalk fields in the fall of 1892 showed conclusively that there was no single species of bacteria constantly present in the organs of these animals that could be cultivated under ordinary conditions. The evidence was convincing that if the bacillus of the corn disease did invade the organs of cattle it was either destroyed or rendered incapable of subsequent development on media satisfactory for the growth of the bacillus isolated by Professor Burrill. From Billings's report it is evident that the bacillus which he described is cultivated without difficulty. Billings, however, traced the origin of this disease in cattle to the affection of cornstalks described by Burrill[1] in 1889. The theory which he advanced was that the bacillus in the affected corn ingested by the cattle produced rapidly fatal results (septicæmia).

A review of Professor Burrill's description of the disease in the cornstalks shows that it attacks (1) the young corn in which the roots are first affected, and (2) the full-grown stalks after midsummer, when it manifests itself by certain discolored areas, more particularly on the leaf sheaths. In the young plant the disease, which is restricted to certain limited areas, dwarfs the stalks, resulting in the loss of the crop, while in the mature plant it is widely distributed and does not appear to be possessed of economic importance. The same species of a bacillus was isolated by Burrill from both the diseased root of the young corn and the lesions on the leaf sheath of the mature stalk. Billings[2] also states that "this corn disease is exceedingly local in its extension, being not only limited to certain fields, but even to certain portions of such fields and most probably to certain stalks in a hill, or at least to individual groups of stalks." It appears, therefore, that Billings recognized but one form of the corn disease and his illustrations[1] show that to be the disease in the mature plant. It appears, therefore, that he mistook the disease in the full-grown corn, which is exceedingly common, for the more rare affection manifested in the dwarfed stalks, which he considered responsible for the death of the cattle.

---

[1] Those interested in the disease of corn are referred to Professor Burrill's paper on a New Bacterial Disease of Corn, Bulletin No. 6, University of Illinois, Agricultural Experiment Station, 1889; Proceedings of the Society for the Promotion of Agricultural Science, 1889, 19.

[2] Loc. cit.

This reported scarcity of the disease of corn said to be fatal to cattle, the failure to find a specific organism in the organs of the cattle examined in 1892, and the rapidity of the disease with symptoms said to resemble those of poisoning, led to the supposition that possibly animals which died while feeding in cornstalk fields might be poisoned from the bacterial products stored up in the diseased cornstalks. This led to an investigation of the cornstalk disease in its relation to the affection of cattle.

In August, 1893, I consulted Professor Burrill at Champaign, Ill., in reference to the corn disease which he had described. He very kindly offered me the use of his laboratory and personally pointed out the disease which he had described in the full-grown corn, and indicated the character of the lesions from which he predicted I would obtain pure cultures of the bacillus which he had found. It was too late in the season to study bacteriologically the dwarfed corn (result of the disease in the root of the young plant), and consequently my investigation of that form of the disease was limited to certain feeding experiments hereafter described. The examination of the disease in a large number of cornfields showed the lesions to correspond with the description of the disease in the mature plant as given by Professor Burrill, and consequently a further account of its appearance is not necessary.

A large number of agar and glycerin-agar cultures[2] were made from the lesions indicating the first stages of the disease in the leaf sheaths from cornstalks taken from fields at or near Champaign, and also from similarly diseased corn from several other localities, more especially about Kankakee and Mazon. A few cultures were made from the dead roots of the dwarfed corn and from the erosions (old lesions) on the leaf sheaths, but these invariably developed, as predicted by Burrill, impure cultures often containing fungi which, on account of their rapid growth, caused the cultures to be abandoned.

---

[1] The technique employed in making the cultures was very simple. The cornstalks were selected which showed from the exterior minute discolorations on the leaf sheaths. These were cut close to the ground and taken to the place where the cultures were made. The leaves and upper part of the stalks were then removed. The lower part was washed in a one-thousandth solution of corrosive sublimate. The closely fitting leaf sheaths were then removed by making first a deep circular incision just above the node, from which the diseased sheath was removed entirely or in part by means of gentle pressure with sterile forceps. With sterile (flamed) instruments a bit of the affected parenchymatous tissue was removed and placed in the culture media. It is of interest to add that a platinum loop rubbed over the inner surface of the freshly removed but tightly fitting leaf sheaths and then drawn over the inclined surface of agar in most cases showed these surfaces to be germ free. When the sheath was loose, however, its inner surface became contaminated with bacteria and fungi.

[2] Bulletins 22 and 23, Nebraska State Experiment Station.

A careful examination of a large number of cornfields situated at short intervals across the central and northern parts of the State of Illinois showed the disease in the mature corn to be exceedingly abundant. Later observations revealed its presence in the States of Indiana and Maryland, and it is highly probable that it is even more widely distributed.

The dwarfed corn was found to be quite rare. In addition to the statement that this was limited to certain circumscribed areas, it was learned that these areas always produced dwarfed cornstalks when the crop was repeated year after year. Mr. McClure, assistant horticulturist at the State University of Illinois, directed my attention to this disease on the farm of Mr. Hay, near Kankakee, Ill. I found in his cornfield a large number of areas, varying in size from a few square rods to an acre or more, upon which the corn was dwarfed and worthless. This was considered by both Mr. McClure and Professor Burrill to be a most typical example of the effect of the disease attacking the root of the young plant.[1]

About 80 per cent of the cultures made from the first stages of the disease in the leaf sheaths contained a bacillus not distinguishable from the one described by Burrill. From the other cultures four species of saprophytic bacteria were obtained frequently in pure cultures. Although the bacillus described by Burrill was found in large numbers in the diseased cornstalks, its absence from the organs of the cattle dying in the cornstalk fields in 1892 rendered it desirable to test the pathogenesis of the affected cornstalks themselves. It was the intention to select thoroughly infected cornstalks and to feed them to cattle without an admixture of other food. The necessity for this artificial experiment, however, was eliminated by existing conditions brought about by more natural causes.

A drought which extended over the greater part of the State of Illinois in August and September, 1893, dried up the pastures and compelled the farmers to feed their cattle. In many instances cornstalks were the only food given. As all of the corn was found to be affected with this disease, it was evident that no feeding experiment could be planned that would be more efficacious than those already being made. Several herds of cattle that were fed exclusively on these stalks were carefully watched for a period of several weeks, but no evidence of disease appeared. The cornstalks fed were carefully examined and found to be thoroughly infected with the Burrill disease. It should be noted that the cattle ate these stalks much closer than they did dried ones in the field later in the fall, and consequently they ingested many more of the diseased areas. It is of interest to add that so far as it was possible to learn, the cornstalk disease did not appear among cattle in 1893 in the districts visited in the fall and where the mature cornstalks were known to be badly affected by the Burrill disease. Unfortunately, no feeding experiment with the dwarfed corn was carried out with cattle. An experiment was planned for late in the fall with the dwarfed stalks from Mr. Hay's field, but a severe storm destroyed the stalks to such an extent that it was impossible to complete it. Enough of the blighted stalks were collected, however, for a rabbit experiment.

---

[1] I was first informed by Mr. McClure, and subsequently by others, that the germ theory of the dwarfing of the corn was losing ground and the previously entertained one, that it was due either to animal parasites or to a lack of "something" in the soil, was being revived. A careful study of this form of the disease is being made by both Mr. McClure, of Champaign, and Mr. Hay, of Kankakee. Mr. Hay is testing the efficiency of various fertilizers. He has found that a considerable portion of his land invariably yields dwarfed and worthless corn, while the land immediately adjoining it always produces a good crop. Thus far his experiments show that with a proper amount of fertilizers his land, which otherwise gave no corn, will yield a profitable crop. His experiments promise a practical method for preventing the loss now sustained from this cause.

FEEDING DISEASED CORNSTALKS TO RABBITS.

Dr. Billings[1] fed the leaves of the diseased corn to a rabbit with fatal results. From the organs he obtained cultures of a bacillus identical with the one which he had isolated from the diseased organs of cattle dying of the cornstalk disease. In his writings concerning the distribution of the bacteria in the stalks and the difference in the pathogenesis of the organism isolated from different portions of the plant we find the following remarkable statement:

> That it is in the stalks I myself have demonstrated by microscopic examination and cultures; but with this singular result: It is not disease producing when inoculated from this source in either rabbits or mice, while from the leaves it is, as we have seen from the feeding experiment in the black rabbit.

In the fall of 1892, a bundle of corn leaves and tassels was collected from an infected field (Outbreak No. 5) and sent to the laboratory at Washington for feeding rabbits.

Two rabbits were fed exclusively upon these leaves for a period of four weeks, during which time they remained apparently well. The animals had plenty of fresh water but no other food during this time. About three months after the feeding of the stalks one of the rabbits died. It was emaciated, but bacteria could not be found in cover-glass preparations from the organs, and culture media inoculated from them remained sterile.

In the fall of 1893, two feeding experiments were made with stalks known to be affected with the Burrill corn disease.

---

[1] Bulletin Nos. 7, 8, 9, and 10 (one volume), of the Agricultural Experiment Station of Nebraska, 1889, p. 134.

(1) Feeding of the leaf sheaths from the mature cornstalks.

(2) Feeding of the dwarfed stalks (disease in young corn).

In the early part of September several bushels of the badly diseased leaf sheaths were collected in the State of Illinois. Care was taken to select only those sheaths which were diseased and which presumably contained a very large number of bacteria. These were sent to the laboratory of the Bureau and used for feeding rabbits and for a chemical analysis. Likewise in the latter part of September a considerable quantity of the dwarfed yellow stalks, including leaves and roots, were received from Mr. Leon Hay, of Kankakee, Ill., whose cornfields contained many areas on which the corn was dwarfed and yellowish. Four rabbits were fed on each variety of the diseased cornstalks. The details of these experiments are given in the subjoined tables:

A.—*Feeding rabbits with the diseased leaf sheaths.*

Rabbit No.	Date feeding was begun.	Stopped feeding.	Remarks.
69	Sept. 6, 1893	Oct. 4, 1893	Emaciated; otherwise well.
70	.....do......	....	Died Oct. 21. Emaciated; no other lesions observed; no bacteria discovered in the organs.
71	.....do......	Oct. 4, 1893	Somewhat emaciated; otherwise well.
72	.....do......	.....do......	Do.

B.—*Feeding rabbits with dwarfed cornstalks.*

Rabbit No.	Date feeding was begun.	Stopped feeding.	Remarks.
73	Sept. 22, 1893	....	Died Oct. 17. Very poor; no lesions; cultures made from blood, spleen, liver and kidneys remain clear.
74	.....do......	Nov. 1, 1893	Somewhat emaciated; otherwise well.
60	.....do......	.....do......	Do.
61	.....do......	.....do......	Do.

The rabbits were given plenty of water and all of the stalks (cut up) they would eat. They did well on the dwarfed cornstalks, but those fed only upon the leaf sheaths began to lose flesh after about two weeks, when they were given a small quantity of other food (wheat bran and oats) with the cut leaf sheaths.

The cause of death in rabbits Nos. 70 and 73 was not determined. It is highly probable, however, that it was due to malnutrition. The only abnormal condition that was discovered was marked emaciation. Tubes of agar and bouillon inoculated with bits of the organs and blood remained clear.

EXPERIMENTS TO ASCERTAIN THE EXTENT TO WHICH CORNSTALK FIELDS IN WHICH CATTLE HAVE DIED ARE DANGEROUS.

It was shown in the notes on the outbreaks of the disease in cattle that all of the animals that died in any particular cornstalk field did so in a very few days, and that the remaining animals were not appreciably affected. The cause of this peculiar condition can not be satisfactorily explained until the etiological factor is determined. A high degree of susceptibility of the animals to the normal constituents of the cornstalks would presumably give rise to such a phenomenon. If the cause is a specific one, such as a microorganism, the clinical history would indicate that the destructive agent was either concentrated, so that the cattle which perished were the only ones that had become infected, or that it was more generally distributed and that a tolerance was established in those which survived presumably by reason of small initial doses. An important and interesting fact is that where the number of cattle was small and the acreage of corn large, all of the deaths occurred before the cattle had fed to any extent upon the cornstalks. In view of these facts a few experiments were planned by which it was hoped to demonstrate whether or not the destructive agent was eliminated from the fields with the first deaths. The plan suggested was to turn cattle which had been either on pasture land or in cornstalk fields in which no deaths had occurred into the infected field immediately after the deaths in the first herd had ceased. As it was the general opinion among the farmers consulted that after the first deaths no further loss would be sustained, some difficulty was experienced in obtaining suitable cornstalk fields for this purpose and also in securing satisfactory cattle. In the fall of 1892 only one such experiment was made, and it proved to be of little value, as the owner of the cattle insisted upon removing them from the field on account of the severe cold weather and a heavy fall of snow. In the fall of 1893 the following experiment was carried out by Dr. F. L. Kilborne:

In Outbreak No. 13 (page 33), which occurred on the farm of Mr. McCleary, of Van Meter, 5 animals from a herd numbering 35 died while feeding in a 20-acre cornstalk field within four days after they were turned into it. The cattle were in the field five days.

December 5, five days after the cattle were removed from the field, 20 2-year-old steers were turned into it. Ten of these were from a herd that had been in cornstalk fields, located about a mile distant, for about five weeks. The other 10 were from the herd first turned into the field and had been yarded since November 29. These were returned to further test their power of resistance.

At the time the experimental cattle were turned into the field there was about 8 inches of snow on the ground, which did not entirely disappear until the close of the experiment. There was no snow on the ground at the time the cattle in the first herd died, but other outbreaks have occurred in the presence of a greater or less quantity of snow, so that presumably this condition had no influence on the result.

During the experiment the cattle obtained water and salt the same as those which suffered from the disease.

Before the experiment was begun a wagonload of stalks on which smut had grown was cut for a more specific feeding experiment with that article. Only about one-fourth of the husks, leaves, or tassels usually eaten by the cattle had been consumed by the first herd.

The 20 steers remained in the cornfield continuously until December 16, a period of eleven days, without the appearance of the disease. They were then removed.

THE BACILLUS OF THE BURRILL DISEASE OF CORN.

The observations and experiments with the diseased cornstalks already recorded are enough to show the innocuous nature of its supposed specific organism. There are, however, several interesting facts in connection with this bacillus. As previously stated, a bacillus was obtained in pure cultures from about 80 per cent of the media inoculated with the beginning lesions in the cornstalk disease. In cover-glass preparations they usually appeared in considerable numbers, especially in those made from the gum-like substance frequently found in the inside of the leaf sheath beneath the lesions.

Although Professor Burrill very satisfactorily described the bacillus he found, according to the requirements of that time, the development of new methods for differentiating bacteria shows that a positive identification of bacteria recently isolated with those previously described is a matter of much difficulty, excepting where definite and characteristic pathogenic or physiological properties exist. In this case, however, I was fortunate in receiving from Dr. Smith a culture of a bacillus originally obtained from a culture of the bacillus of the cornstalk disease sent to him by Professor Burrill. A comparative study of the two cultures enabled me to identify the bacillus which I had isolated with the one previously received from Professor Burrill. It was found, however, that these bacteria differed from the original description in their growth upon gelatin. They both liquefied this medium. The liquefaction took place very slowly, however, which may explain the statement in Burrill's description that it does not occur, as he failed to state the age of the culture when last examined. As these bacteria in other respects correspond with the original description, this variation under the existing conditions does not appear sufficient for differential purposes. A study of these and the closely allied bacteria has shown that the power to liquefy gelatin and the quantity of gas produced by the fermentation of certain sugars varies somewhat as a result of continued artificial cultivation. The large amount of the disease in corn after midsummer led to a bacteriological examination of the soil from fields in Maryland, which resulted in finding very abundantly a bacillus closely related to the one obtained from the diseased cornstalks, and probably identical with it.

In 1893 Dr. Theobald Smith[1] identified the bacillus received from Professor Burrill and the one with which I compared my cultures as *Bacillus cloacæ*.[2] He also reports this organism from well water, both "polluted and unpolluted."

---

[1] Wilder Quarter-Century Book, 1893, p. 214.

[2] This bacillus was isolated from sewage and was originally described by E. O. Jordan. Experimental investigations by the State board of health of Massachusetts upon the purification of sewage, etc. Part II, 1890, p. 836.

The cultures of this organism obtained from different sources were carefully studied in parallel cultures and found to differ very slightly. The greatest difference between them was in certain physiological manifestations. As this bacillus has already been described it seems necessary at this time to point out only the more essential differential properties of the bacillus obtained from the diseased cornstalks.

DESCRIPTION OF THE BACILLUS.

Morphology.—A motile bacillus varying in length from 1.3 to 2 μ, ends rounded Appears in cultures singly or united in short chains or clumps. From five to fourteen flagella have been demonstrated. It stains readily with aniline dyes.

Cultural characters.—It develops a grayish, somewhat vigorous, glistening, nonviscid growth on the surface of agar. In the depth of agar it is more feeble. Gelatin is softened along the needle track and beneath the quite vigorous grayish growth which appears on the surface at the end of six days. It liquefies very slowly. The liquid gelatin is clear, with a viscid, grayish sediment. Strongly alkaline in reaction. On potato a dull grayish, nonviscid growth appears within twenty-four hours. In alkaline bouillon the multiplication is quite active, the liquid becoming heavily clouded in twenty-four hours. The casein of milk is coagulated in about eighteen days. It possesses active fermentation properties. In the fermentation tube filled with bouillon containing 2 per cent dextrose the closed bulb is filled with gas in forty-eight hours. The liquid is very acid in reaction. The gas consists of 72 per cent CO_2 and 28 per cent H. In a similar tube containing saccharin the fermentation is quite as active, but the proportion of the gas constituents is different, being 66 per cent CO_2 and 34 per cent H. In bouillon containing lactose the closed bulb of the tube is not filled with gas until the fourth day. The gas is practically the same as that produced in the saccharin bouillon.

The pathogenesis of the bacillus isolated from the lesions on the cornstalks was tested by a large number of inoculations with pure cultures into rabbits, guinea pigs, and mice. The animals were inoculated by different methods and with varying quantities of culture. One rabbit which received 0.75 c. c. of a bouillon culture in the ear vein died in fourteen days. It was very much emaciated, but no other evidence of disease was discovered. Bacteria were not found in the organs or blood. All of the other inoculated animals remained well.

The discovery of *Bacillus cloacæ* in the soil is of much significance. It harmonizes the results obtained by Professor Burrill in his bacteriological examination of the roots of the affected corn with the early conclusion that the cause of the dwarfing of the corn is not primarily the result of bacteria. It also explains how it is possible for the parenchymatous tissue of the leaf sheaths, husks, and leaves to be so generally sprinkled with lesions containing this organism. Whether these organisms are of themselves able to gain entrance into the parenchymatous tissue of the leaf sheaths after being lodged by various agencies against the exterior of the plant, or whether they are inoculated into the tissues by means of insects or injuries to the epidermis otherwise inflicted is not determined. The experiments of Professor Burrill would indicate the possibility of their power to penetrate the epidermis of the leaf sheath.

It appears that this organism, which is strongly saprophytic in many of its tendencies, is capable of multiplying in the tissues of the living corn plant, and consequently may be considered a facultative parasite.

A few cultures made from similar lesions contained a total of four other species of bacteria, which evidently had survived for a greater or less time in the parenchymatous tissue of the leaf sheaths, and, to all external appearances, had produced lesions not distinguishable from those associated with *Bacillus cloacæ.* This shows the existence of other usually saprophytic bacteria capable to a certain extent of such a parasitic life. The infrequency of their appearance, however, would indicate either their existence in the surroundings in much smaller numbers, or that, on account of their strongly saprophytic nature, they are unable to survive in the tissues of the living plant. Mr. H. L. Russell[1] has recently shown that a large number of bacteria, mostly saprophytes, are able to live for certain periods of time and to spread to a limited extent in living plant tissue.

CORN SMUT (USTILAGO MAIDIS) NOT FATAL TO ANIMALS.

Although the feeding experiments made by Professor Gamgee in 1868 and those at the Illinois State experiment station more recently, described on pages 11 and 15, gave negative results, it seemed desirable to make still further tests of the etiological power of this fungus. To this end the two following experiments were made by Dr. F. L. Kilborne:

(1) The load of cornstalks affected with smut (*Ustilago maidis*) removed from the field used in a preceding experiment (page 44) were fed to three 2-year-old steers, placed separately in box stalls in a barn on Mr. McCleary's farm. The animals had been in a cornstalk field for about five weeks prior to the feeding. They were fed exclusively on the smut-laden cornstalks and free smut mixed with a small quantity of a mixture of corn meal and wheat bran for seven days without ill effects. Owing to the absence of necessary appliances the weight of the animals and of the smut fed was not taken. It is safe to say that these animals consumed a much greater quantity of smut than the animals which died in the field It was observed that the cattle did not eat the smut readily in the field, and in this experiment the animals refused it until apparently hunger compelled them to eat. The mixing of mill feed with the pure smut made it more appetizing, and consequently a much larger quantity was eaten than otherwise would have been done. The fact should be borne in mind that the smut used in this experiment came from a cornfield in which several animals had died within five days after they were turned into it.

(2) In December, 1893, six barrels of corn smut were collected from several cornfields in which cattle had not been turned, near Van Meter, Iowa, and shipped to the experiment stations of this Bureau. This material comprised both the abortive ears with the husks attacked by the smut and the masses of pure smut found growing on the stalks.

---

[1] Bacteria in their relation to vegetable tissue. Report of the Johns Hopkins Hospital, Vol. III (1893), p. 223.

The total weight was 280 pounds, of which at least one-half was smut.

Two heifers, Nos. 238 and 284, 15 to 18 months old, were placed in separate box stalls. They were bedded with peat moss instead of straw, in order that their food should consist exclusively of the prescribed ration. They were allowed to run in a small yard (16 by 30 feet) for about five hours daily.

During the experiment the animals were given all the well water they wished. They were not salted. The smut was apparently not relished by the heifers, especially by No. 238, so that it required considerable inducement to get them to eat the desired quantity.

Beginning on the morning of January 17, 1894, and continuing until noon of February 2 (sixteen and one-half days), the heifers were fed morning and evening with from 2 to 3 quarts of a mixture of equal parts by weight of cut hay and a mixture of corn meal, middlings, and wheat bran, and 16 quarts of smut. The actual quantity of the fungus consumed by No. 239 was 61 pounds, or a daily average of nearly $3\frac{7}{10}$ pounds, and by No. 284, $67\frac{1}{2}$ pounds, or a daily average of $4\frac{1}{8}$ pounds. The temperature of the animals was taken every morning and evening. The animals appeared to be perfectly well throughout the time of feeding, and continued so for several months during which time they were kept under close observation.

Table showing the temperature of animals during the feeding experiment.

Date.	No. 238.		No. 284.	
	8 a. m.	5 p. m.	8 a. m.	5 p. m.
1894.	*Degrees F.*	*Degrees F.*	*Degrees F.*	*Degrees F.*
January 16	....	102	....	102.7
January 17	101.2	101.4	101.5	102.4
January 18	101.4	101.4	101.6	102
January 19	101.2	101.8	101.5	101.4
January 20	101	101.8	102	102.2
January 21	101.4	101.6	101.8	102.6
January 22	101.4	101.8	102	102.5
January 23	100.8	101.8	101.8	102.4
January 24	100.4	101.8	101.8	102.4
January 25	100.7	101.7	102.2	102.4
January 26	100.2	101.2	100.8	101.5
January 27	101	101.2	100.7	100.8
January 28	101	102.2	100.8	102
January 29	100.7	102.2	101.6	102.2
January 30	100.8	101.4	101.7	101.6
January 31	100	102	101.6	102.6
February 1	100.6	102	101.6	102
February 2	100.4	....	100.8	....

Several masses of the smut fed in this experiment were brought to the laboratory and examined microscopically to determine whether or not there were other fungi parasitic upon or associated with the *Ustilago maidis*, and which might possess destructive properties. These examinations failed to reveal the presence of any such organism. The negative results obtained in these experiments are additional evidence of the nonetiological importance of this fungus, at least so far as its power to produce disease in cattle is concerned. Careful search was made in the cornfields in which cattle had died for any diseased condition of the corn, or for the presence of other plants or fungi which might be possessed of poisonous properties. Thus far no evidence of such a cause for the disease has been found.

ANIMALS OTHER THAN CATTLE NOT AFFECTED.

It has been of considerable interest to determine whether or not animals other than cattle are affected with this disease. Billings states that other herbivorous animals and horses are sometimes attacked. An agricultural paper, in estimating the total loss from this cause, includes a considerable number of horses. The replies to the circular letter (page 17), giving information on this disease, show that horses and sheep occasionally die while pasturing in cornstalk fields. It is a significant fact that the reports, by circular letter, of this disease in horses were for the greater part from people residing in the State of Kansas, and that Dr. Mayo[1] describes a disease[2] in horses (*Enzoötic cerebrites*, or "staggers") as occurring very extensively in the State of Kansas during the fall and winter of 1890 and 1891. He further states that there was very little cornstalk disease during this season.

In these investigations I found horses pasturing in cornstalk fields where cattle died in five of the eighteen outbreaks. Hogs fed upon the carcasses of the dead cattle in two outbreaks. Sheep were pastured in the cornstalk field in one instance. In this limited number of exposures the disease was not found in any of these animals. We have failed, therefore, to find any evidence of the existence of this disease in horses, sheep, or swine.

CHEMICAL ANALYSES.

Early in these investigations the necessity was felt for a knowledge of the chemical constituents and the physiological properties of cornstalks, especially those grown in the fields where cattle had died of this disease. Accordingly, small quantities of the following substances were collected and sent to Dr. E. A. de Schweinitz, chemist of the Bureau, for an analysis, especially with reference to the alkaloids or other substances which might be of a poisonous nature:

(1) Cornstalks, mostly leaves and tassels, from the cornfield of Mr. C. Johnson. (Outbreak No. 5, 1892.)

(2) The diseased leaf sheaths collected at Mazon, Ill., in August, 1893.

---

[1] Bulletin No. 34, Experiment Station of the Kansas State Agricultural College, 1891.

[2] This disease is said to have been caused by a fungus, *Aspergillus glaucus*, on moldy corn which was ingested by the horses. The spores of this mold are stated to gain entrance to the circulation and find lodgment in the kidneys and liver, more frequently in the latter. The spores germinate and cause inflammation of these organs. The cerebral symptoms are the result of the formation of an abscess in the brain. This is caused by an interference with the blood supply, probably from spores or mycelia of the mold in the circulation. The spores of this fungus seem to retain their infections properties for about six months. Mayo was unable to cultivate this fungus from the organs of the dead horses.

(3) The diseased cornstalks (dwarfed) from the farm of Mr. Leon Hay, of Kankakee, Ill., which were sent to the laboratory late in September, 1893.

(4) Liver of steer No. 11, which was sent to the laboratory in glycerin in December, 1893.

For the results of these analyses the reader is referred to the accompanying report of Dr. de Schweinitz. It appears, however, that they did not reveal the presence of any alkaloidal poison or inorganic salts in unusual or abnormal quantities. The necessity for a more extended chemical investigation is indicated in the discussion on the etiology of the disease on a subsequent page.

DISCUSSION ON THE NATURE OF THE DISEASE BASED UPON DATA OBTAINED IN THE SPECIAL INVESTIGATIONS.

The data recorded in the preceding chapter permits a more comprehensive view of this disease and of its economic importance than could heretofore have been taken. Although many important facts in the natural history of this malady are yet unknown, an analytical study of the results obtained will show that this disease of cattle is not such a plague to the Western farmers as it has been depicted.

CONDITIONS UNDER WHICH THE DISEASE OCCURRED.

The apparently contradictory statements made by farmers and cattle raisers concerning the conditions under which this disease occurs are clearly explained by the diverse management under which cattle dead from this malady were found in these investigations. A review of the essential facts determined in the different outbreaks summarized in the appended table will show that the fallacy of the popular theories is undoubtedly to be found in the fact that they are based on the conditions surrounding a very few outbreaks.

A synopsis of the general conditions found in the investigated outbreaks of cornstalk disease.

Outbreak.	Locality.	Date.	Total number of cattle.	Number that died.	Length of time cattle were in cornstalk fields daily.
1	Red Oak, Iowa	November, 1892.	70	2	First 6 days, 3 hours. Continuously.
2	do	do	56	1	First 3 days, 2 hours. Continuously.
3	Ames, Iowa	do	7	2	All day; yarded at night without food.
4	Red Oak Iowa	do	24	4	First 3 days, 2 to 3 hours. Continuously.
5	Tyner. Iowa	do	22	7	Continuously.
6	Mechanicsville Iowa	do	37	2	Do.
7	Toledo Iowa	do	21	3	First few days, 5 hours. Continuously.
8	Stennett, Iowa	December, 1892	25	5	First few days, 3 to 5 hours. Continuously.
9	Wales. Iowa	do	40	3	First few days, 3 to 5 hours. Yarded at night.
*10	do	November, 1892.	15	2	Continuously.
*11	Emerson, Iowa	do	140	10	Do.
12	Woodbine, Iowa	do	33	5	First few days, 3 to 5 hours. Continuously.
13	Van Meter, Iowa	October, 1893	35	7	Continuously.
14	New Providence, Iowa.	do	52	15	First 3 days, 2 to 3 hours. Continuously.
15	Percival, Iowa	November, 1893.	100	22	Continuously.
16	Corning, Iowa	do	75	9	Do.
17	Hastings, Iowa	December, 1893	70	7	Do.
18	Red Oak, Iowa	do	226	18	Do.

A synopsis of the general conditions found in the investigated outbreaks of cornstalk disease—Continued.

Outbreak.	Food other than cornstalks.	Size of cornfields.	Condition of corn.	Kind of land.	Water supply.
		Acres.			
1	Clover, meadow, and pasture.	20	Good	Upland	Spring (trough).
2	Clover meadow	About 40	....do	....do	Well.
3	None	13	....do	Upland. One-fourth acre, low and wet.	Do.
4	Clover pasture	20	....do	Upland	Do.
5	Millet and hay	12 60	Good on upland.	Small area of lowland in each field.	Stream.
6	Cut corn and tame hay.	3	Good	Upland	Well.
7	Pasture	20 30	Good on upland.	Nearly all upland	Do.
8	....do	15 20	Good	Upland	Stream.
9	None	10 20	....do	....do	Well.
*10	....do		....do	....do	
*11	....do		Fair	....do	
12	....do	20 20 20	Good	....do	Stream.
13	....do	25 20	Fair to good	....do	Spring.
14	....do	20 25 20 35	First 2 fields good, otherwise fair.	Nearly all upland	Stream.
15	....do	80	Good	Bottom land, low	Do.
16	Pasture	80	....do	60 acres upland, 20 acres, lowland.	Well.
17	None	70	....do	Upland	
18	....do	40	....do	Lowland	River.

Outbreak.	Salt given.	Time animals were known to be sick.	Quantity of smut (*Ustilago maidis*) on corn.
1	Frequently	4 to 12 hours	Less than usual.
2	Constantly in the field	Found dead	Very little.
3	Once in 5 days	1 found dead; 1 sick 2 hours	Do.
4	Once in 7 days	2 found dead; 2 sick 12 hours	Considerable.
5	Frequently	Some found dead; others sick a few hours.	Small amount.
6	....do	4 to 5 hours	None (?).
7	Salt in trough constantly	3 to 12 hours	Considerable. All picked and drawn out of field when corn was harvested.
8	None	4 found dead; and 1 sick a few hours.	Moderate amount
9	Twice a week	A few hours	Small amount.
*10	None		
*11	....do		
12	Frequently	Found dead, or sick a few hours.	Considerable.
13	....do	....do	Small amount.
14	Irregularly at first, later in field continuously.	Found dead	Do.
15		....do	Moderate quantity.
16		Usually found dead	Considerable.
17		Found dead	Do.
18		....do	Very little, much less than usual.

---

* At the time outbreaks Nos. 10 and 11 were reached the cattle had been dead for several days and the owners were not present. The fragmentary knowledge concerning them was obtained from other members of the families.

From the table it will be observed that in eleven of the eighteen outbreaks the animals had plenty of salt, in three instances no salt was given, and in four outbreaks this fact was not determined. The animals in each of the outbreaks had free access to an abundant supply of water, or were provided daily with well or spring water.

The cornfields in which two of the outbreaks occurred were entirely on lowland. In nine outbreaks they were entirely on upland, and in seven they were on high and low land, but for the greater part on upland. The growth of the corn was vigorous in every field on the upland, and with few exceptions the crop was a good one on the lowland. The quantity of smut on the corn varied from very little to unusually large quantities. In one instance (Outbreak No. 7) all of the smut-bearing stalks were cut and drawn out of the field at the time the corn was harvested. In most instances the cattle were allowed to remain in the corn stalks for from one to three hours only each day for the first three to six days, while in the others they were left in them continuously. In a few instances the cattle had no other food than the cornstalks, but in the majority of cases they had access to stacks of hay or straw, or were allowed to run at will over pasture or meadow lands.

A careful inquiry into the common practice of farmers in certain sections of the country where this disease occurs disclosed the interesting fact that the conditions under which the cattle were usually kept, and the methods followed in wintering them, where no deaths occurred differed in no appreciable manner from those where many animals died. It was found that farmers as a rule furnish their cattle with plenty of salt and water, and that they usually take the precaution of allowing them to remain at first for only a few hours daily in the cornstalk fields. The practice of giving other food is frequently followed. In fact, so far as I have been able to determine, the methods followed by those who lose cattle and those who do not are identical. On this account obvious and peculiar conditions, which may be considered as favoring the appearance of the disease or forming a means for its prevention, have not been discovered. The method of caring for cattle by one man who loses heavily may be followed by a neighbor whose herd remains free from the disease, although the cornfields may be on apparently the same kind of soil and separated from each other only by a fence or at most by a public highway.

It was found that in certain outbreaks the cattle were pastured consecutively in two or more cornstalk fields. In these cases the deaths usually occurred in the last field, but in a few instances very soon after transferring the animals. The time which elapsed after the cattle were turned into the cornstalks before the first death occurred was variable, though usually from five to eight days. This is of much importance, and in order to make a comparative study of this point with reference to the outbreaks investigated the appended table has been constructed:

Outbreaks.	Total number of deaths.	Number of cornstalk fields cattle were in.	Fields in which death occurred.	Number of deaths and days on which they occurred after the cattle were turned into the cornstalk fields in which they died.													
				1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.
1	2	1	First..*											1		1	
2	1	1	First				1										
3	2	1	First					1	1								
4	4	1	First								1	1		1			1
5	7	*2	First and second	†2					4					‡1			
6	2	1	First									2					
7	3	2	Second									1	2				
8	5	2	Second					3	2								
9	3	2	Second							1	1		1				
10	2	1	First					1							1		
11	5	1	First								2	3					
12	5	3	First and second		§3					2							
13	7	2	Second		1	5	1										
14	15	4	First, second, and third					‖10	1	4							
15	22	1	First						10			¶12					
16	9	1	First						1			8					
17	7	1	First				7										
18	18	1	First			1				17							

*Where the cattle were in two or more fields the time occupied in each varied from one to two weeks.

†One steer died on the first day in each field. In the first instance death resulted presumably from the effect of dehorning.

‡The cattle were kept out of the cornfield for three days (seventh, eighth, and ninth) after the death of the four animals.

§All in the first field.

‖Eleven animals died in the first field. Two died in the second and two in the third field on the seventh day after being turned into them.

¶The twelve animals died between the sixth and eleventh days.

The table shows that the great majority of deaths occurred from the fifth to the eighth day after the cattle were turned into the cornstalks. In the seven cases where the animals were in two or more fields deaths occurred in the first in three instances, and usually the time which elapsed after turning the animals into the second field, before they began to die, was as long as ordinarily occurred when they perished in the first field. This fact may be used as an argument to show that the causative agent was absent in the first, but present in the second field.

The previous history of the cattle was not obtained in all cases, but usually they had been turned into the cornstalks directly from pasture lands. As the cattle were not turned into the cornstalk fields until late in the fall it is evident that they had been feeding for several weeks upon grass more or less affected by repeated freezing.

The prevalence of the disease among young cattle was especially noticeable. Although the great majority of all the cattle in the herds in which deaths occurred were young, a few of the dairy herds consisted of young and old animals. In these the old ones invariably remained well. Those which suffered most were calves, yearlings, and 2-year-olds.

SYMPTOMATOLOGY.

As previously stated, opportunity was not afforded to observe an animal suffering from this affection prior to death. The insidious nature and rapid course of the disease usually results in the death of the animal before its presence is detected. In a few instances, however, the sick animals were observed very carefully by their owners, from whom all the knowledge we have of the symptoms was obtained. Although little dependence can be placed on symptoms as ordinarily described by unprofessional and especially interested persons, a careful questioning rendered it possible to eliminate many of the customary exaggerations and to obtain a list of the more apparent manifestations of the disease.

Mr. Bixler (Outbreak No. 1) found a steer lying down and unable to rise. His head was extended, resting on the ground and moving continually from side to side; this was kept up for several hours, when he died. In the second case a steer was found to remain behind the other animals when they were driven to water about 11 a. m. At 3 p. m. he was found in a dying condition.

Mr. Williams (Outbreak No. 4) found his animals apparently well at 5 a. m. At 7 a. m. a heifer was found resting squarely upon her knees, the head extended and resting upon the ground. She was frothing at the mouth and groaning as if in great distress and died in about two hours.

Mr. Miller (Outbreak No. 5) found a calf lying down and unable to rise. The head rested on the ground and the eyes were rolled up. It kicked considerably and appeared to suffer intensely. It was shot in a few hours to relieve its sufferings. Another calf was found sick in the morning. It was placed in a barn, where for a few hours it was furious in its efforts to get out. Later in the day it laid down and could not be induced to rise. It was quiet part of the time, but usually kicked and bellowed as if in much distress and refused all food. There was a normal movement of the bowels in the afternoon.

Mr. C. Johnson observed a steer to act as if "crazy" at night. It was found dead the following morning.

Mr. J. G. Jones (Outbreak No. 9) observed several cases. The animals were very quiet. One of them exhibited a semi-comatose condition.

Mr. Hunt (Outbreak No. 12) described the symptoms to be similar to those observed in a dog poisoned with strychnine.

Mr. McCleary (Outbreak No. 13) stated that the sick animals were dull, exhibited great weakness, and walked with a peculiar jerky movement of the hind legs. The animals trembled as if suffering from a chill. In a short time they fell down and appeared to be in great distress, heads moving continually backward and forward.

Mr. Hadley (Outbreak No. 14) observed a sick animal trembling violently for about two hours preceding death.

Although the descriptions of the actions of the affected animals as given by the owners differ somewhat, there is a striking resemblance between them. It is unfortunate that a more thorough examination, especially in reference to the temperature, pulse, and respiration, was not possible in this investigation. These important symptoms will necessarily remain undetermined until the opportunity of recording them is presented to properly trained persons.

It will be observed that the symptoms given by Gamgee do not differ materially from those here enumerated. Billings gives considerable space to the symptomatology of this disease, but for the greater part it is confined to the inoculation disease. On the evidence given we cannot at present accept the artificially produced disease as being identical with the cornstalk disease as it occurs in nature.

MORBID ANATOMY.

In all, twelve animals which died in cornstalk fields were examined. Post-mortem changes were more or less advanced in the greater number of these, although a few were examined soon after death. The post-mortems showed that while the macroscopic lesions were usually obscure and varied much in degree, they were constant and uniform in character. As would be expected, the structural changes in the various organs were very slight. This explains the statement of many veterinarians that the organs of cattle dying of cornstalk disease are normal in appearance. A summary of the lesions found in the twelve cattle examined, and their distribution in the body, is appended:

Nature and distribution of the lesions.

[Organs marked (*a*) were decomposed to such an extent that they were rejected.]

Animal No.	Outbreak.	Brain.	Lungs.	Heart.	Liver.	Spleen.	Kidneys.
*1	1	Normal	No hepatization.	Normal	(*a*)	(*a*)	(*a*)
*2	1	do	do	do	(*a*)	(*a*)	Pale.
3	3	do	Normal	Hemorrhages beneath epicardium.	(*a*)	Enlarged; blood beneath capsule.	Hemorrhages beneath capsule.
4	3	Hemorrhage beneath pia.	do	Hemorrhagic	Enlarged: œdema about peritoneal attachment; hemorrhagic areas.	Enlarged; hemorrhagic.	Hemorrhages beneath capsule.
†5	4		do	Normal	Center of lobules deeply reddened.	Pulp soft.	Hyperæmic.
*6	5	Normal	do	(*a*)	(*a*)	(*a*)	(*a*)
7	8	do	do	Hemorrhages beneath serosa.	Center of lobules pale; periphery reddish.	Fibrous tufts on capsule.	Cortex pale.
8	8	do	do	do	do	do	Do.
*9	10		do	do	Mottled; acini indistinct.	Dark	Cortex conjested.
10	13	Normal	do	do	Acini distinct, centers reddened.	Enlarged; ecchymoses beneath capsule.	Normal.
‡11	13	Punctiform hemorrhages in meninges.	do	do	do	Ecchymoses beneath capsule.	Do.
12	18	Soft	do	do	do	Normal	Do.

* Post mortem changes well advanced.
† Brain not examined, as the animal was killed in the last stages of the disease by a blow on the he
‡ Intestines were removed before our arrival.

Nature and distribution of lesions—Continued.

Animal No.	First and second stomach.	Third stomach.	Fourth stomach.	Duodenum.	Remaining intestines.	Lymphatics.
*1	Normal	Contents very firm.	Hyperæmic, few ecchymoses.	Hyperæmic, few ecchymoses.	Normal	Normal.
*2	do	do	Hyperæmic	do	do	Do.
3	do	Normal	Normal	Normal	do	Punctiform hemorrhages.
4	do	Contents unusually soft.	Hyperæmic	Ecchymoses	Areas of congestion in ileum and cæcum.	Normal.
†5	do	Normal	do	Areas of congestion.	Areas of congestion.	Do.
*6	do	do	do	do	do	Do.
7	do	do	Areas of congestion.	do	Congested with hemorrhagic areas.	Œdematous.
8	do	do	Deeply congested.	do	do	Do.
*9	do	do	do	do	Lower ileum congested.	Normal.
10	do	do	Hyperæmic, with punctiform hemorrhages.	Normal	Normal	Do.
12	do	Contents firm.	Normal	do	do	

* Post-mortem changes well advanced.

† Brain not examined, as the animal was killed in the last stages of the disease by a blow on the head.

The table shows that the only gross pathological changes observed were those of a hemorrhagic nature. The hemorrhages were mostly confined to the serous membranes, and especially those of the heart. Ecchymoses were more or less numerous, however, beneath the pleura and over the surface of the liver and spleen. The mucosa of the intestinal tract showed areas in which the capillaries were deeply injected with occasional hemorrhage. In one case (No. 4) there were pronounced hemorrhagic areas in the heart muscle, aorta, and pleura.

The liver was frequently pale; the acini presented deep reddish centers with pale peripheries. Usually, however, post-mortem changes precluded the determination of the appearance of this viscus at the time of death.

The inner and middle zones of the lobules were more densely congested than the peripheral ones. A layer several lobules in thickness immediately beneath the capsule was usually more engorged with blood than the deeper portions of the organ. In the more densely injected areas not only the blood spaces were filled, but the liver cells were also separated from each other by a space of variable width containing blood corpuscles. In some cases there were slight changes in the appearance of the cellular protoplasm.

In all of the animals examined, in a suitable condition, the hemorrhages were of recent origin and the blood normal in its microscopic appearance. There were no discolored areas indicative of old ecchymoses. The distribution and general character of the hemorrhages, which are the most conspicuous macroscopic lesions observed, are very similar to those described in certain cases of vegetable poisoning, more particularly that of fern root.[1]

Although certain symptoms described by the owners were referable to the nervous system, lesions were not discovered in the brain or spinal cord excepting in one case (No. 4), in which there was considerable hemorrhage beneath the pia mater.

In one animal certain of the lymphatic glands exhibited more or less blood extravasation, particularly in the interlobular tissue.

Although somewhat limited in number, these examinations have shed much light upon two important lesions heretofore supposed to exist in this disease, viz, impaction[2] of the omasum (third stomach) and lung disease (pneumonia).

The third stomach (omasum) was found in one case (No. 1) to be firmer than normal. In all the others it was either normal or the contents were unusually soft.

In all of the animals examined the lungs were normal. It should be repeated that in addition to the twelve cases carefully considered, nearly as many other animals in which post-mortem changes were advanced were opened and the lungs found to be free from hepatization. The number of animals examined is enough to demonstrate the absence of pneumonia as a characteristic lesion in this disease. Furthermore, evidence to indicate a relation existing between this affection and the various forms of pneumonia to which cattle are susceptible was not discovered. This is important in view of the writings of Dr. Billings, who gives pneumonia as one of the most characteristic lesions in the disease.

Although the lesions are usually not conspicuous, the hemorrhagic changes described are readily detected upon careful examination. Unfortunately we have not the symptoms to compare with the lesions in those cases showing the less marked pathological changes. In the case in which the hemorrhages were most extensive (No. 4) the animal was reported to be sick but two hours and to have given evidence of intense suffering. The fact should not be overlooked that all of the animals from which this data was obtained had been in cornstalk fields from five to eleven days before death occurred. It will be seen from the table on page 53 that a few deaths occurred both before and after that time, but unfortunately an opportunity was not afforded of examining animals which died after such extreme exposures.

---

[1] Journal of Comparative Pathology and Therapeutics, September, 1893; also editorial, June, 1894.

[2] The popular idea of "impaction" has presumably arisen from the fact that the contents of this viscus is normally much firmer than is ordinarily supposed.

BACTERIOLOGICAL EXAMINATIONS.

A review of the results of the bacteriological examinations will show that a considerable number of bacteria were isolated from the organs of the dead animals. A careful study of these forms brought out the very significant fact that the same species of organisms was not obtained from any two of the animals, and that, with two exceptions, the same species was not found in more than one organ of the same animal. This fact renders it highly probable that the death of the animals was not due to the presence of any of the organisms isolated. The additional facts that none of these bacteria possessed unusual biological properties and that none of them were pathogenic for rabbits and mice are further indications that they were either the result of contamination from without, owing to the unfavorable conditions under which the cultures were made, or that they had migrated from some of the mucous membranes of the body to the organs in which they were found. As the greater number of the bacteria were recognized as ordinarily observed saprophytic forms it is highly probable that they were in many cases the result of external contamination. This supposition is supported by the fact that the greater number and variety of bacteria were isolated from cultures made from animals that were examined in barnyards or cow sheds with a strong wind blowing, and in the presence of several individuals who were constantly walking about, thus stirring up a considerable quantity of dust.

A more important fact in eliminating the theory of the bacterial origin of this disease is that the great majority of the tubes of culture media inoculated from the various organs and tissues of the affected animals remained clear. In all, twelve distinct species of bacteria were isolated which were not readily recognized saprophytes. Generically, there were six motile and two nonmotile bacilli, three micrococci, and one streptococcus. None of these forms produced gas in bouillon containing glucose, and they were harmless to experimental animals. The conditions under which the cultures were necessarily made were such that bacteria extremely sensitive to an exposure to a low temperature, or suited only to certain kinds of culture media, could not develop. With very few exceptions, and those unsatisfactory, no attempts were made to make anærobic cultures in the field. Agar was generally used, although a few tubes of glycerin agar, gelatin, and bouillon were inoculated with the animal tissues.

The failure to observe bacteria in the large number of cover-glass preparations and sections made from the various organs of the different animals is also evidence that bacteria discoverable by our known methods of staining were not present in the tissues. The blood cultures[1] (from two cases only), made by drawing about 20 c. c. of blood from the heart with sterile pipettes and transferring it to sterile tubes, which were exposed as soon as possible to a temperature of from 30° to 37° C., remained clear.

---

[1] This method was recommended by Dr. Billings to be very efficacious in the detection of the specific bacillus of this disease.

The failure to discover a specific or even constantly present organism in the diseased animals was paralleled by the few independent cultures made by Dr. Niles, who assisted in many of the autopsies. The fact that he made independent cultures is important, as he used culture media prepared in his laboratory, while mine was made in the laboratory of the Bureau. Although presumably a given bacillus would grow equally well in both media, the fact that media from two laboratories were employed in making cultures from the same animal shows that the failure to obtain the Billings or other organism was presumably not due to any peculiar or deleterious property which the media used by me might for any reason have possessed.

In 1892 it was impossible to make rabbit inoculations with the fresh tissues. In 1893, however, a few rabbits were inoculated with the blood and several with the brain tissue from Nos. 11 and 12. All of these rabbits remained well.

The difficulties attending the bacteriological investigation of this disease are obvious, and the use of delicate methods for the cultivation of anærobic bacteria, as well as those necessary for the study of organisms requiring a constant temperature, can not well be made in field examinations. In these investigations cultures were made in sufficiently large numbers and with the necessary care to warrant the conclusion that there is no species of bacteria which can be cultivated under ordinary conditions constantly present in the organs of cattle dying of cornstalk disease.

The negative results obtained by Professor Burrill in his examination of the Craig case in 1889 (page 15), and those of Dr. Niles from the same animals I examined are in harmony with this conclusion.

ETIOLOGY.

The varied conditions under which the cornstalk disease has been found to occur show that the existing theories concerning the cause are not in accord with the observed facts. A causal relation of corn smut to the death of the cattle can not be entertained in view of the clinical and experimental evidence that it can be eaten with impunity. The "germ theory" is likewise shown to be incapable of demonstration, and cornstalks affected with the Burrill disease have been shown to be wholesome food for cattle. The careful microscopic examination of both fresh and fixed organs and blood from a number of affected animals for the purpose of determining whether or not death might be due to the invasion of protozoa or other minute parasitic organisms, has invariably given negative results.

A careful analysis of the reports of this disease received from many interested persons, as well as the published statements already referred to, shows quite conclusively that different agencies take part in the production of the total number of the deaths annually attributed to this disease. When deaths occur within twenty-four hours after cattle are turned into the cornstalk field it is highly probable that ordinarily the cause is due to mechanical interference rather than to the effect of any specific agent, either organic or chemical in its nature. The well-known and rapidly fatal condition known as "hoven," due to the repletion of the rumen with solid food or from the evolution of gases arising from the contents undergoing certain fermentation, is presumably the cause of many of the deaths which occur within a few hours.

Dr. Going, in a paper read before the Kansas State board of agriculture in 1890, describes an enteritis in cattle produced by pasturing them in cornstalk fields late in the fall and winter. He states that the animals are sick for several days and are amenable to treatment. It is not unreasonable to suppose that many of the deaths occurring after several weeks of feeding exclusively on the dry and leached cornstalks would result in the development of a more or less severe gastritis. Veterinarians are familiar with a disease in cattle due to malnutrition and indigestion produced by the continuous feeding upon pasture grass during the winter or after it has been killed by frost. In these cases the symptoms are said to be similar to those described by Dr. Going.

The engorgement and drying of the contents of the third stomach or "impaction," is reported on good authority to occasionally cause death in cattle fed upon dry food. This condition very likely occurs more or less frequently in cattle feeding continually upon dry cornstalks. In these examinations, however, it has not been found, with one exception, and deaths from this cause are believed to be infrequent. In addition to the above there are many accidental causes, such as poisoning and traumatic injuries, which presumably occasion a few deaths that are attributed to cornstalk disease. Thus I have learned of the death of a steer which occurred within twelve hours after turning the animal into the cornstalks. This death was reported to be due to the cornstalk disease but it undoubtedly resulted from dehorning, as the hemorrhage was reported to be excessive and the weather severe.

There are, however, many deaths which can not be explained by the intervention of these known agencies or conditions, and which should be included under the popular designation of "cornstalk disease." In these investigations the animals thus affected had been in the cornstalk fields from two to fourteen days, but the greater number of deaths (see page 53) occurred in from five to eight days after the first exposure.

As already stated, the existing theories concerning the cause of the disease have not been verified, and the outcome of the observations and experiments made during these investigations indicate that the exciting cause is quite different from those heretofore announced, although the exact etiological factor has not been demonstrated.

The symptoms and clinical history, so far as obtained, and the lesions in the animals examined indicate that this disease is due to a poison.

It is evident that the determination of the nature of the toxic substance can not be made until the facts obtainable by chemical analyses concerning both the inorganic and organic constituents of cornstalks and their toxic properties upon cattle are recorded. It is furthermore not clear whether this toxic condition is due to an excessive quantity of the poisonous substance or to an unusual susceptibility on the part of certain animals. The fact should be noted that ordinarily cattle are late in the fall turned from pasture lands on which the grass has been repeatedly frozen into the cornstalk fields. This sudden change from a sparing diet to an overabundance of a single highly nutritious food would be expected to produce more or less derangement in the animal economy. The exact effect upon the animal body of the normal salts or alkaloids in the cornstalks when taken in such abundance after a period of partial fasting can not at present be recorded. The large quantity of the corn fodder stored up in the rumen during the first few days permits of the accumulation of these principles in the animal body.

The effect of different soils upon the quantity of the inorganic salts in cornstalks seems not to be fully understood. It is stated that corn has the property of taking up from the soil a large per cent of potash, which appears in the cornstalks as nitrate of potash, and which is poisonous to cattle. Mayo[1] has recently shown that cattle fed upon certain corn fodder died from poisoning with the nitrate of potash which the corn contained. He also found that cattle eating cornstalks from the same field were affected differently, some dying, while others remained well. He reports a most remarkable quantity of nitrate of potash in certain cornstalks, as the following quotation will show:

> Beneath the leaf sheath which surrounds the stock just above the joints the nitrate had crystallized in fine white crystals which resembled a white mold, but was easily recognized by tasting with the tongue. Around and in the cut ends of the stalks were solid masses of almost pure potassium nitrate. If a stalk was cut in two and tapped lightly upon the table, the crystals of potassium nitrate would be jarred loose and fall as fine powder upon the table. These stalks were grown on land adjoining a barnyard which formerly was used as a hog yard. The examination of cornstalks from a field some distance from the yard failed to reveal the existence of potash by the method previously referred to.

These observations are of much importance, as it is possible they may afford a key to the etiology of this disease. The lesions in the affected cattle reported by Dr. Mayo show much greater intestinal disturbance than those found in the animals I have examined. I have carefully examined many of the cornstalks in several of the fields in which cattle died, but have not in any instance found the presence of perceptible quantities of any crystallized substance either beneath the leaf sheath or in the stalk. This discrepancy can be readily explained by the observation that these salts appear in perceptible quantities only in corn grown on soils containing large quantities of certain fertilizers.

---

[1] Bulletin No. 49, Experiment Station of the Kansas State Agricultural College, 1895.

Another fact that points to the probable toxic nature of this disease is the recovery of certain animals (see Outbreaks Nos. 13 and 16) which showed symptoms similar to those manifested by the animals which died. It was observed by the owners of these cattle that after the crisis was passed they recovered very rapidly. Although this disease is generally supposed to be invariably fatal, it is highly probable that a large number of animals are affected and recover.

The possibility of the existence of a fatal poison in the cornstalks is shown by the report of Dr. Mayo. It is not determined, however, that potash or sodium compounds are the only substances which might be produced in unnatural proportions under certain conditions in the corn plant. As the fatal quantity of known toxic substances appears to vary much in cattle, owing somewhat to the condition under which they are administered and largely to the degree of susceptibility of the individual animals, it seems to be necessary that further chemical analyses of cornstalks should be made. The stalks should be taken under different conditions, such as late in the fall, after their exposure to the fall rains and frosts, and when grown on different kinds of soil and the physiological and toxic properties of the substances thus obtained should be tested on cattle previously kept under different conditions. As the accumulated data point to the toxic nature of this disease, that hypothesis is provisionally assumed although the exact nature of the poison is not yet determined. It appears, however, to be restricted to the corn plant, and for that reason the disease it produces is designated *Toxæmia maidis.* The theory of the toxic effect on certain animals of the normal constituents of the cornstalks when taken in large quantities is strengthened by the fact that the disease does not occur in those sections of the country where the corn stalks are cut and properly cured, and where they are subsequently fed to cattle in small quantities, but sufficient in amount to keep the animals in good condition. It is hoped that chemical investigations of this disease may clear up the doubtful points.

ECONOMIC IMPORTANCE.

It is difficult to estimate the amount of loss caused by this disease. There are no statistics from which reliable data can be obtained concerning it, and, while it occurs to a certain extent every year, it is reported to be more frequent some seasons than others. It is usually confined to one or two herds in a single neighborhood, but its distribution is irregular, and frequently townships, counties, and even larger districts in the generally infected territory remain free from its ravages for years in succession.

Dr. Billings[1] summarizes the loss from this disease by stating that "it can be safely said that this malady causes more loss in cattle to the Western farmer than all other causes combined, not excepting abortion."

---

[1] Loc. cit.

Pyle[1] reports the loss in Nebraska for the season 1889 and 1890 to be about $61,000.

The Farmers' Review for February 5, 1890, contains a summary of the reports of their correspondents concerning the prevalence of the cornstalk disease in the major portion of the corn-growing States.

The figures which are given are so divided between money value and the number of animals which perished that an accurate statement can not be made concerning either, but approximately[2] they are as follows: From Nebraska, a loss of $59,094 among cattle and $5,250 among horses. In Iowa, about 1,800 cattle and a few horses. In Missouri, about 350 cattle and a few horses; several counties are reported as sustaining a loss of from 1 to 7 per cent of their cattle. These statements show an enormous loss, but the text is not clear as to whether or not all of these animals died in the fall and winter of 1889 and 1890.

In the replies to the circular letter already mentioned, 634 men reported an ownership of 39,324 cattle, of which 3,229, or about 9.8 per cent, died in cornstalk fields in a single season.

In the twelve outbreaks investigated in 1892, 490 cattle were pastured in cornstalk fields in which the disease appeared and 46 of them died. In 1893, the percentage of loss was 14.5 per cent of the animals that were turned into cornstalk fields where the disease appeared, i. e., of the 558 animals exposed 81 died.

In estimating the percentage of loss from this disease there is great danger of an overestimate. In the township of Red Oak, Montgomery County, Iowa, there were 2,460 cattle in 1892, of which, so far as I could learn, only 6, or about one-seventh of 1 per cent of the total number, died in cornstalk fields. Further inquiry showed that in the entire county there were 29,169 (number recorded in county clerk's office) cattle, of which only 17 perished in cornstalk fields. Other years the loss was reported to be heavier, and still others less. These figures are given to show that the percentage of cattle which die in cornstalk fields is small when the thousands of herds in which the disease is not recognized, if it occurs at all, is considered.

The data obtained, therefore, show that this disease is not of such great economic importance as it has been thought. As it is noncontagious, it does not threaten the cattle industry of this or other countries to which American cattle may be shipped. In the herds where deaths occur the amount of loss is frequently heavy, but the infrequency of its appearance renders the average annual loss of cattle in any community from this disease exceedingly small. It is the universal testimony of the more experienced farmers that the amount of this disease is diminishing from year to year. Notwithstanding, it is a source of serious loss and its prevention and elimination from the country is much to be desired. To accomplish this the method of prevention about to be indicated is urgently recommended.

---

[1] Journal of Comparative Medicine and Veterinary Archives, XIII, 1892.

[2] In the reports from counties some of the statements give the number of cattle, others the value of the cattle, and still others both the number of animals and their value. From the latter, the average value of an animal was estimated and from this result the approximate amount of loss was estimated.

PREVENTION OF THE DISEASE.

The rapid course of this disease indicates that prevention is the only practical remedy. As it appears in widely separated herds, there being many localities where it has never occurred, it is evident that the practical application of any general precautionary measure must be attended with very little expense, or the burden of prevention would be heavier than the loss of the occasional animals. As the disease is not contagious measures to prevent its spread are not called for, and the adoption of any method is for the sole purpose of protecting individual farmers against a possible loss of one or more animals from this disease. It has been shown that the methods now in vogue are not trustworthy, and the adoption of those heretofore suggested would, from the nature of the disease, be impracticable.

It has been observed in these investigations that a few farmers residing in the States where the disease is most prevalent, and who cut and feed their cornstalks after the method followed in the Eastern States, never lose cattle from this disease.[1] This is further illustrated by the history of the malady. Formerly it was the custom of the farmers in the States of Ohio and Indiana to turn their animals into the cornstalk fields after the ears had been picked from the standing stalks, and they reported losing many cattle from this disease. More recently the farmers in these States, with possibly few exceptions, cut their corn when it is ripe, and subsequently feed the properly cured stalks to their cattle. Frequently these stalks constitute the food for the cattle throughout the greater part of the winter. Where this practice is in vogue the cornstalk disease has disappeared. At the present time the practice of cutting the cornstalks is becoming prevalent in the State of Illinois, and several agriculturists of that State have stated that the losses from this disease are growing less and less each year. Although these illustrations may be considered coincidences, they conform to the long experience of the farmers of the Eastern and Middle States, who invariably cut their corn and feed the cured stalks and who never lose cattle from this malady.

In view of the history of this disease and the facts brought out in the investigations, the only method of prevention which commends itself to the consideration of the farmers who wish to protect their herds from this malady is to cut their corn when ripe, cure the stalks, and subsequently feed them to their cattle. This method is based upon the experience of agriculturists as well as upon theory. The results of more scientifically arranged experiments could not be more demonstrative than those obtained by the actual experience of thousands of farmers.

---

[1] A most interesting illustration of this was found by Dr. E. C. Schroeder in the State of Missouri, in 1891. The conditions were as follows: Two farmers had large cornfields separated from each other by a wire fence. One of these men pastured his cornstalk field and lost heavily from the disease; the other cut his corn and fed the stalks with no ill effects whatever. The only difference in the conditions that could be found was in the method of feeding.

This method of prevention, if generally followed, will necessarily cause a radical change in the practice of farmers in the sections of country in which this disease occurs. At first thought it may seem impractical and unworthy of consideration, but a more careful study will show that it can be practiced with profit, especially on the smaller farms, where the amount of corn and the number of cattle are not large.

This method is urgently recommended, not only as a means of preventing an occasional loss of from 5 to 30 per cent of the cattle feeding in a cornstalk field, but also in its great economy of corn fodder.[1] The waste resulting from cattle running in cornstalk fields is notorious. The universal testimony of farmers who are feeding their cattle cut and properly cured cornstalks is that it pays. The quality of the stalks is much superior to that of the weather-beaten and bleached stalks left standing in the field. In addition to this, the amount of fodder obtained from a certain area is much increased over that utilized when the cattle run at will in the standing stalks, so that from a given acreage of corn a much larger number of animals can be wintered. While this means of prevention may not be practicable where large herds are driven from the Western plains to be wintered in the corn-growing sections where the acreage of cornstalks is extravagantly large, it is deemed practicable wherever economy in the use of forage becomes necessary. The slow but constantly increasing rapidity with which this method of feeding cornstalks is advancing from the East shows that it is a question of a few years before the custom will become universal throughout the West. When that time arrives the cornstalk disease of cattle will presumably not appear.

---

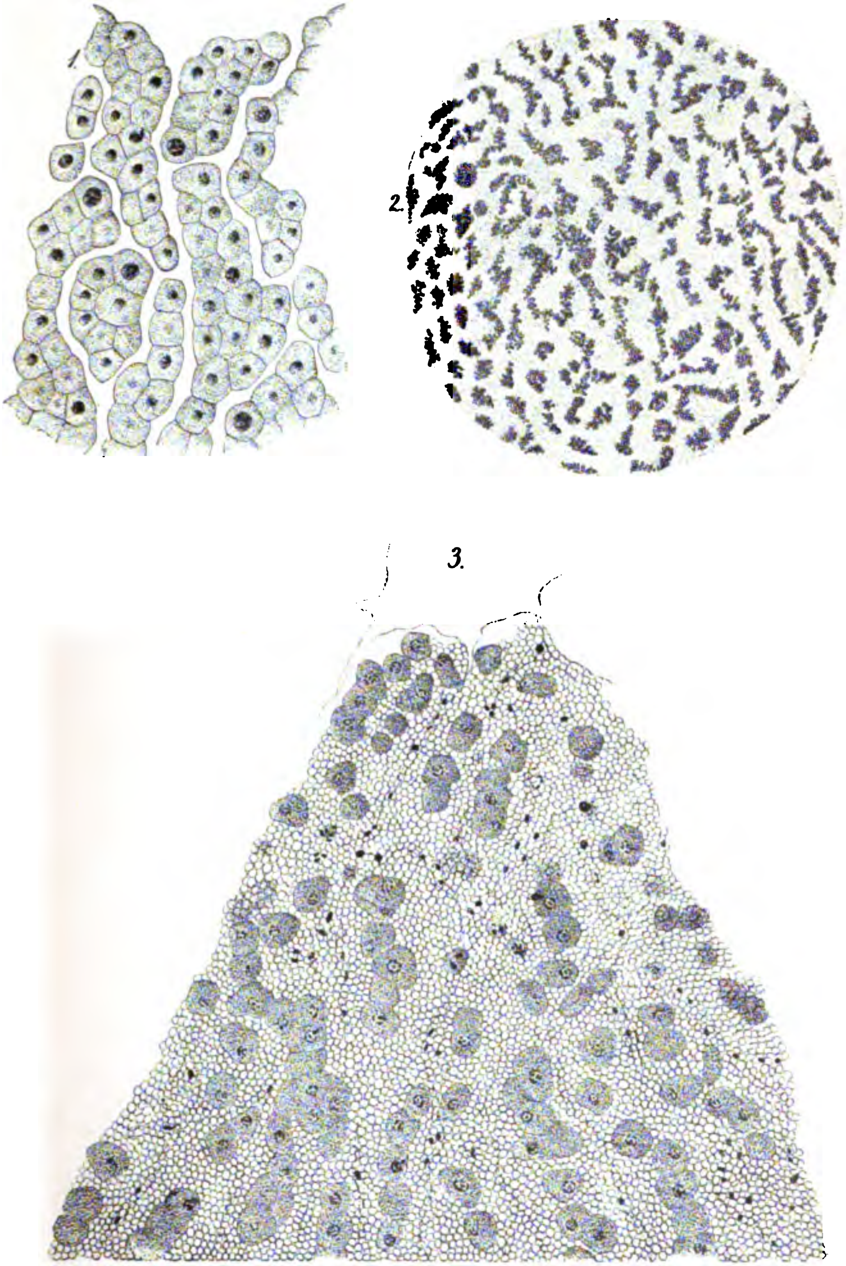
[1] The importance of cornstalks as forage has been clearly set forth from a scientific standpoint by H. J. Patterson (Agricultural Science, Nos. 7, 8, and 9, Vol. VI, 1893), who has made a chemical analysis of the separate parts of the corn plant, such as the ear, husks, tops, leaves, stubble, etc. This analysis shows that the stalks contain a greater total of food constituents than the corn itself. He also shows that there is but little difference in the digestibility of different parts of fodder and that all its compounds, except the protein, are more digestible than those of timothy hay. He shows, furthermore, that the digestible matter in the fodder alone from an acre of good corn equals the digestible matter in 2 tons of either clover or timothy hay.

DESCRIPTION OF PLATE I.

FIG. 1.—A drawing made from a section of a lobule of the liver of a healthy cow, showing liver cells and the blood spaces (magnified 500 diameters).

FIG. 2.—A drawing from a section of liver from steer No. 4. This shows the liver cells and the engorgement of the blood spaces. Drawing traced with camera lucida, 8 mm. apochromatic objective; No. 4 eyepiece.

FIG. 3.—A drawing from a section of the liver of steer No. 3, showing the separation of the liver cells and the intercellular spaces filled with blood (magnified 500 diameters).



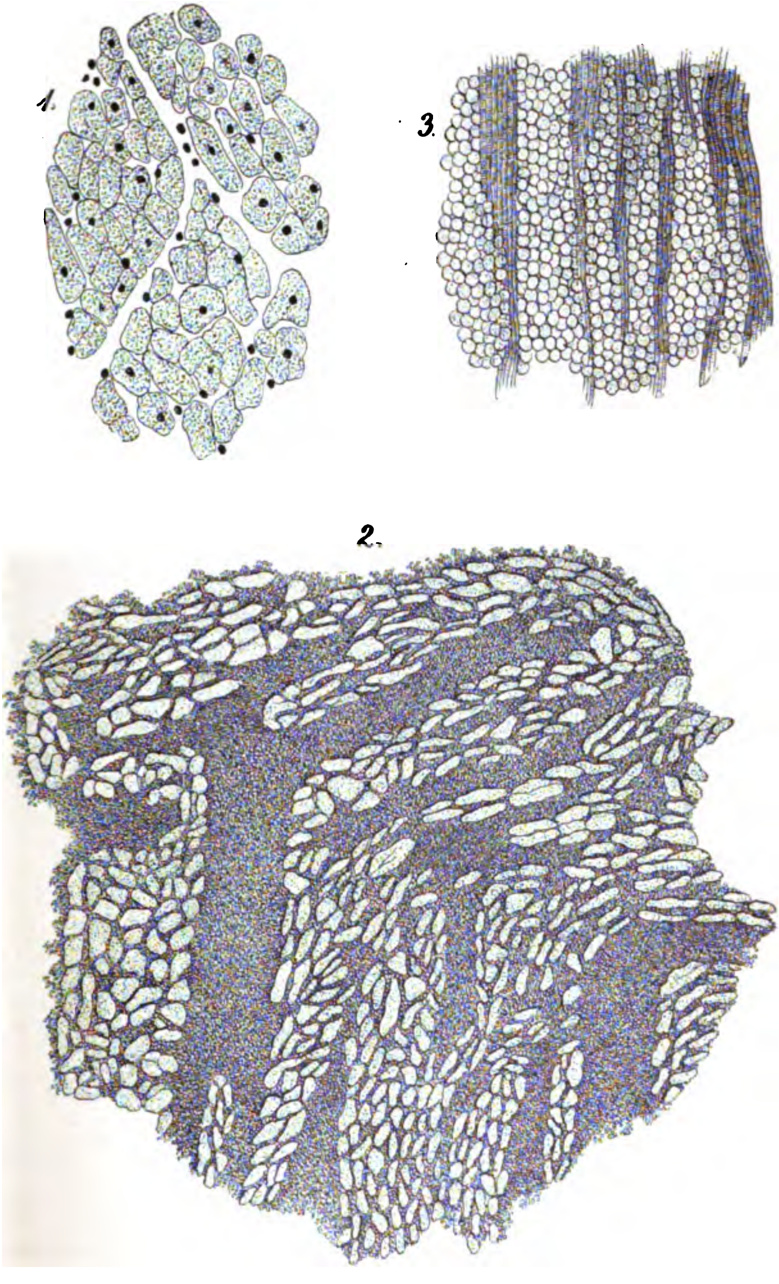
ENGORGEMENT OF BLOOD IN THE LIVER.

DESCRIPTION OF PLATE II.

FIG. 1.—A drawing from a section of normal heart muscle of a cow, showing cut ends of fibers (highly magnified).

FIG. 2.—A drawing from a section of heart muscle from steer No. 4. This shows the hemorrhage into the connective tissue surrounding the fibers and bundles of fibers. Traced with camera lucida, 8 mm. apochromatic objective; No. 4 eyepiece.

FIG. 3.—A drawing from the same section as fig. 2, showing longitudinal fibers and bundles of fibers surrounded with blood corpuscles. The muscle fibers themselves are not affected (magnified 500 diameters).



HEMORRHAGES IN THE HEART MUSCLE.

A DISEASE IN CATTLE NOT DISTINGUISHABLE FROM RABIES.

By **Veranus A. Moore.**

While investigating cattle diseases in the State of Iowa in the fall of 1892, Dr. Stalker, State veterinarian, called my attention to a peculiar affection which had appeared at variable intervals during the summer among the cattle belonging to Mr. John Wade, who resided near Greene, Butler County. The mystery surrounding this malady, as well as its economic significance, rendered an inquiry into its nature and cause exceedingly desirable. I therefore visited Mr. Wade on November 10, in response to a telegram announcing the reappearance of the disease. The following history of the affection was obtained:

Early in the spring of 1892, 47 2-year-old steers were turned into a pasture containing 100 acres, the greater part of which were on slough land. The field contained several acres, however, that were dry and covered with tame grass. In the slough portion water stood for a greater part of the summer between the bogs or tufts on the tops of which wild grass grew in abundance. The cattle were salted weekly, and water was pumped daily from a well at one side of the pasture into a large trough standing in the field. The well was bored through limestone rock and was said to be about 100 feet deep.

Late in June or early in July a steer was found dead. About a month later a second animal died. Early in September a third steer was taken sick and died in about three days. October 1, 2 steers died and later in the month 4 others perished. The last 4 animals were observed to be sick for about six days prior to death.

There were two other smaller pastures on high land, in which were 25 and 27 steers, respectively. In September, 100 cattle were purchased and turned into the pastures on the upland. Early in October the surviving cattle from the slough pasture were turned into the fields on the upland with the purchased animals. They were all fed subsequently on timothy and clover hay and snapped corn. The 4 steers which died late in October had, therefore, been on high land and fed as stated above for about three weeks prior to death. None of the cattle pastured during the summer in the fields on high land had died, and all the subsequent deaths were among the cattle which had been summered on the slough pasture. Mr. Wade had not lost cattle in previous years, and to his knowledge this disease had not before appeared in his vicinity.

Mr. Wade had already lost 9 animals, and subsequently 7 others died. Of the latter 4 were examined very soon after death. The symptoms observed in the sick animals, which were similar to those said to have been manifested by the previously affected ones, and the absence of apparent lesions sufficient to cause death, suggested the probability that they were dying of rabies. As indicated by this provisional hypothesis, rabbits and calves were inoculated with the brains of 3 (Nos. 1, 4, and 5) of the 4 animals for the purpose of obtaining data whereby a positive diagnosis could be made. The results demonstrated the fact that these animals were affected with rabies, or at least with a disease not distinguishable from that malady as determined by comparative inoculation experiments. A careful inquiry was made into the prevalence of rabies in the vicinity. It was learned that about 12 miles from this place several animals, all of which died of rabies, were bitten by a rabid dog about a year before. This was the only case of the disease found to have occurred, at least for several years, in this or adjoining counties.

As the source of infection is exceedingly difficult to explain, this outbreak is of much interest. The possibility of the presence of a rabid dog can not be gainsaid. Accepting it as a fact, it is quite an unusual condition to have animals bitten by a rabid dog early in the spring, die of rabies at variable intervals throughout the summer and early winter. The fact that no other animals in the neighborhood died, that mad or strange dogs were not observed during the entire summer, and that a careful inspection of the skin of the animals examined failed to reveal the presence of scars suggestive of bites or other injuries, all tend to preclude the probability that the cattle were infected at different times by means of the bites of different dogs. The importance of this disease warrants a somewhat detailed description of each of the animals examined, and an account of the inoculation experiments resulting in the diagnosis made.

SYMPTOMS AND LESIONS IN THE CATTLE EXAMINED.

Steer No. 1.

A 2-year-old steer was found in an almost dying condition November 10. He had been sick for five days. When first attacked he was said to have been in good condition, but he was now much emaciated. Mr. Wade stated that the most marked symptoms which he observed in this animal were indifference to food and water, and persistency in driving hogs, dogs, hens, and other small animals from the yard. He would not attack persons. Occasionally he bellowed as if in great distress. The hind limbs were drawn under the body more and more each day, so that by the third day walking became difficult. At times he would run about the yard in an apparent frenzy. When observed (November 10) he walked with great difficulty. The hind legs were drawn under the body and there was marked loss of coordination. In stepping with the hind legs the weight rested first on the toes. After a few steps he would fall on the ventral surface of the body, bringing the four legs beneath him. He could rise only with difficulty. The eyes had a dull appearance and were deeply reddened. Judging from the previous case, Mr. Wade thought that he would live but a few hours. He was killed (by cutting the carotids) for examination.

Autopsy—Steer much emaciated. Mouth and œsophagus normal. Rumen contained a considerable quantity of moist, partly macerated food, consisting of straw, hay, corn, and corn husks. The third and fourth stomachs were normal. The mucosa of the duodenum and jejunum was covered with a layer of bile-stained mucus, otherwise the intestinal tract was normal. Lungs normal. There were a few subserous blood extravasations on the left ventricle. The liver was apparently slightly enlarged, normal in color. There were about 400 c. c. of a thin, clear, greenish-yellow bile.

The spleen was abnormally dark in color. The normal markings were present.

The medullary portion of the kidneys was slightly reddened. Cortex pale. Capsule easily removed. Bladder empty. The lymphatics normal.

The frontal lobes of the brain presented a surface thickly sprinkled with pigment. The blood vessels were slightly injected, especially in the choroid plexus. Spinal cord normal in appearance.

The microscopic examination, on the following day, of the various tissues did not reveal abnormal changes, and stained cover-glass preparations from the various organs and blood did not show the presence of bacteria or other microor ganisms.

Bacteriological examination.—At the autopsy tubes of agar were inoculated with pieces of the brain, liver, kidney, spleen, and the heart blood. Liquid agar was also inoculated with parts of the brain (Liborius' method of making cultures). All of the culture media inoculated with the spleen, liver, kidneys, and blood remained clear. One of the agar cultures of the brain contained *Bacillus flourescens liquefaciens* in pure culture.

November 12 an emulsion was made by grinding up a small piece of the brain tissue taken from beneath the pia of the right frontal lobe with a few cubic centimeters of sterilized water. The brain had been kept in a cool place since its removal (November 10), and when used post-mortem changes were not detected.[1] Two rabbits were etherized and inoculated with one to two drops of the emulsion, one beneath the dura and the other in the anterior chamber of the right eye. The rabbit inoculated in the eye remained well, but the other developed the following symptoms:

November 25, thirteen days after inoculation, the attendant[2] stated that the rabbit acted very queerly. November 26 he showed partial paralysis of both hind limbs and could not stand. Hyperæsthesia of the right hind leg, but the left one was apparently devoid of sensation. The rabbit tried from time to time to get up, but invariably failed. It refused food and water. There was no ferocity manifested; temperature normal. It was found dead on the following morning, fifteen days after the inoculation. The post-mortem showed injection of blood vessels of the heart. The liver was slightly reddened. Several cysticerci in abdominal cavity. Intestinal track normal. At point of inoculation the brain had a pale greenish color over an area 2 to 3 mm. in diameter. Blood vessels of the meninges slightly injected. No other evidence of disease.

Stained cover-glass preparations made from the blood and organs exhibited no bacteria. Tubes of culture media inoculated from the same remained clear.

November 28 a second rabbit was inoculated beneath the dura with a drop of the emulsion prepared from the brain of the dead rabbit. It died December 2. The examination showed an extensive imflammatory condition of the meninges of the brain about the point of inoculation.

---

[1] The delay was necessitated by the distance of the outbreak from Ames and the procuring of the rabbits.

[2] The fact that much of the time I was necessarily in the field prevented the taking of full notes on the symptoms of the animals inoculated at Ames.

STEER No. 2.

This steer was first observed to be sick on the evening of November 10. It showed symptoms similar to those manifested by No. 1 and died November 13. It was examined November 14 in company with Dr. Niles. The post-mortem changes were considerably advanced. The intestinal tract appeared to be normal, with the exception of a thick layer of mucus over the mucosa of the duodenum. The liver, spleen, and kidneys were discolored from decomposition. A considerable quantity of clear, straw-colored serum beneath the dura. The blood vessels of the pia and choroid plexus injected. No hemorrhage. Over the frontal lobes the pia presented a stippled appearance due to fine and coarser pigment. The pigmentation was most intense about the olfactory bulbs. The microscopic examination of the pigment showed it to be composed of roundish or rectangular granules of a dark brownish color, varying from 0.5 to 1.5 μ in diameter.

Several tubes of agar were inoculated from the brain substance at the time of the autopsy. Part of these remained clear; the others developed into impure cultures of saprophytic bacteria.

As the steer had been dead for some time prior to examination rabbits were not inoculated beneath the dura with its brain. A single rabbit, however, was inoculated subcutaneously with a piece of the brain substance and remained well.

STEER No. 3.

A 2-year-old steer was taken sick about November 10, and died during the night of November 12. He was said to have exhibited symptoms similar to those already described. He was examined November 14, but the post-mortem changes were too far advanced to determine any slight abnormal changes at the time of death.

STEER No. 4.

A 3-year-old steer was taken sick November 19. The first symptom noticed was his persistent chasing of all the smaller animals which came near him. This was followed by paroxysms, in which he would run against fences and farm buildings. He was placed in stanchions to prevent him from injuring himself or other animals. He was at all times uneasy, would bite up a mouthful of hay or dirt and act as if in great distress. He ate and drank very little, and swallowed with apparent difficulty. He exhibited the same paralytic symptoms as described for No. 1. The feces were observed by Mr. Wade to be much darker in color than usual. He died on the morning of November 24.

Autopsy.—The examination was made within a few hours after death, the body being still warm. The animal was reported to have lost considerable in weight during the attack. The estimated weight at time of autopsy was 1,100 pounds. The lower jawbone on right side was fractured and the surrounding tissues œdematous. The mucosa of pharynx, larynx, and upper 3 inches of the trachea were sprinkled with punctiform hemorrhages which were also found in small numbers in the lower part of the trachea and larger bronchi. Considerable straw-colored œdema beneath tongue, just posterior to frænum. The lymphatic glands of the throat were deeply reddened and œdematous. Beneath the pleura on the costal surface of the thoracic cavities were numerous blood extravasations, 3 to 10 mm. in diameter. Lungs not collapsed; hyperæmic, but no hepatization in lung tissue. Ecchymoses on base of aorta and over heart. Dark post-mortem clots in both ventricles. Punctiform hemorrhages beneath endocardium over pyramids and around apex of left ventricle. Abdominal organs normal.

The brain presented no abnormal appearance, excepting a slight injection of the blood vessels. The spinal cord appeared to be normal throughout. The brain was carefully covered and placed in glycerin and sent by express to the laboratory at Washington, where rabbit inoculations were made by Dr. Smith. (See page 77.)

Bacteriological examination.—A large number of tubes of culture media were inoculated with different tissues and organs of this animal. The majority of these remained clear. A streptococcus developed in pure culture in media inoculated with the blood. It was extremely delicate in its cultural character, but mice inoculated with a pure culture remained well. This streptococcus perished before its study was completed. A spore-bearing bacillus resembling *Bacillus subtilis* was obtained from the spleen and a nonpathogenic motile bacillus was isolated from the liver.

The microscopic examination of the tissues, both in the fresh condition and in sections of the organs preserved in alcohol and Müller's fluid, failed to reveal any abnormal conditions.

STEER NO. 5.

A steer 3 years old. This animal was first observed to be affected November 21. From that time to November 24 he exhibited symptoms similar to those manifested by No. 4, excepting that the paroxysms were less marked. November 24 this animal came under my observation. He was lying down most of the time. He got up frequently and would walk a short distance and fall. In walking there was considerable trembling of the body. His movements were uncertain, the hind feet were placed well under the body and there was "knuckling" in all four feet, with an apparent loss of coordination. Temperature, 102.3° F.; pulse 42, weak; respiration, 24, not labored; temperature, 101.8° F. Smaller animals, especially dogs, were driven from the yard so long as he could walk, but no signs of ferocity observed. He would come up to a person, but when a hand was placed on his head or nose he would stop and act perfectly docile. Toward night he was unable to stand for more than a few minutes at a time. Eyes were dull and the blood vessels of the conjunctiva considerably injected. November 25 the steer was unable to rise. Conjunctiva deeply congested. Temperature, 91.6° F.; pulse very weak; respiration almost imperceptible. At 11 a. m. he was killed by bleeding.

Autopsy.—Blood appeared normal and clotted readily. No œdema or ecchymoses about mouth, pharynx, or larynx, as in No. 4. Ecchymosis in cephalic and ventral portion of lungs. Lungs not congested, but partially collapsed. A few punctiform hemorrhages beneath the endocardium of the pyramids of the left ventricle; otherwise heart normal. Lymphatics normal. Spleen much enlarged, dark colored, and friable. Upon section the capsule reverts with slight bulging of the pulp. Liver enlarged, edges rounded; in section it presented a dull, pale red color, mottled with grayish areas 1 to 3 mm. in diameter; about 700 c. c. of viscid, very dark colored bile holding solids in suspension, otherwise clear.

Kidneys normal in appearance. There were about 250 c. c. of clear acid urine in the bladder. Examination showed the absence of albumen. No lesions could be found in the intestinal tract. Contents normal.

The blood vessels of the meninges covering the brain were slightly injected. An unusually large amount of pigment on frontal lobes. Blood vessels of choroid plexus much injected. No liquid in ventricles. The gray and white matter normal in appearance.

A microscopic examination of the blood and tissues in a fresh condition showed the epithelium of the kidneys to be slightly granular. Sections of these organs from pieces hardened in alcohol and Müller's fluid showed no appreciable change in the cellular structure. The blood spaces in the liver contained a considerable number of red corpuscles.

Bacteriological examination.—At the autopsy tubes of agar and glycerin agar were inoculated with pieces of the brain, liver, spleen, kidneys, and with several loops of heart blood. The tubes inoculated with the brain, liver, and spleen remained clear. Those inoculated from the blood developed into impure cultures of saprophytic bacteria. A chromogene was obtained from the kidney. About 30 c. c. of the heart blood were transferred by means of a flamed pipette from the heart to a sterile tube. This was placed in an incubator in about eighteen hours. The serum which oozed out of the clot remained clear. Cover-glass preparations from the different organs showed, when properly stained, no bacteria or other organisms.

Anærobic cultures were made after Liborius' method from the kidney, liver, spleen, and brain. All of these remained clear.

November 28 a heifer calf (No. 19) about 2 months old was inoculated beneath the dura with a few drops of a suspension of the brain of steer No. 5. The calf was chloroformed, trephined on the left side of median line, and the emulsion injected beneath the dura by means of a syringe. A small quantity of blood and presumably a portion of the injected liquid escaped after withdrawing the needle. The wound healed nicely. The temperature remained normal for three days, after which it was not taken for a period of twelve days.[1] December 15, seventeen days after the inoculation, the temperature was 100.3° F. The calf appeared to be weak, laid down often, rose without much difficulty, and bellowed frequently. There was considerable dribbling of saliva. December 16, temperature 98° F. December 17, temperature 98.4° F. Calf was very weak, loss of coordination in walking, fell frequently, and rose only after several efforts. Some bloating. Reported by the man in charge to refuse food almost entirely. Dribbling of saliva less marked. December 18, temperature 89° F. Paralyzed. December 19, calf found dead.

Autopsy.—Calf considerably emaciated. Mucosa of mouth and pharynx normal. Lungs normal. Both ventricles contained dark, firm clots. Liver normal in appearance. About 100 c. c. of dark bile holding finely divided particles in suspension. Slight œdema in pelvis of kidneys. Urine dark, cloudy, and acid in reaction. Intestinal mucosa generally covered with mucus, a few punctiform hemorrhages in cæcum. Contents of colon firm and covered with mucus. Lymphatic glands slightly œdematous. The brain and its membranes appeared to be normal. Slight amount of pigmentation. Tubes of agar were inoculated with pieces of the spleen, liver, kidney, and brain. One of the tubes inoculated with the brain contained a few colonies of *Bacillus coli communis;* the others remained clear.

November 26 a heifer calf about 9 months old was inoculated intravenously with 14 c. c. of defibrinated blood from steer No. 5. The calf remained well.

STEER NO. 6.

This animal was taken sick December 8, and died December 12. The symptoms were reported to be the same as those exhibited by previous animals. No post-mortem examination was made.

STEER NO. 7.

A steer 18 months old died during the night of December 13. This animal was found sick December 11, and it was not known how long he had been sick. The symptoms were reported to be the same as those in previous cases. The partial paralysis and "knuckling" were especially well marked. Examination made December 14, at 10 a. m., by Dr. Kilborne.

Autopsy.—General condition good; weight about 500 pounds. Mouth, throat, and lungs were normal in appearance. Heart muscle flabby; the left ventricle nearly filled with a firm post-mortem clot. The right ventricle contained a dark clot and liquid blood. A few punctiform hemorrhages were beneath the endocardium of the left ventricle.

The liver was attached to the diaphragm by firm fibrous adhesions of long standing. The surface was marked by several scars, otherwise the liver appeared to be normal. The gall bladder contained about 500 c. c. of dark greenish viscid bile, holding solids in suspension. The spleen was enlarged to twice its normal size. Pulp of a dark blackish color, and rather soft. Malpighian bodies visible in fresh sections. The enlargement appeared to be due to an increase in the number of red corpuscles. The cortex and base of pyramids of the kidneys pale. Capsules easily removed. The bladder contained about 1,500 c. c. of clear urine. No albumen. The addition of nitric acid produced an unusual amount of effervescence.

---

[1] I am indebted to Dr. Kilborne for the notes on the symptoms and post-mortem condition.

The contents of the third stomach somewhat dry. In the fourth stomach a slight œdema of the laminæ with several erosions of the mucosa. The latter in the duodenum appeared swollen and covered with an abnormal amount of mucus. A slight injection of the blood vessels. In the ileum the mucosa was covered with a thin layer of cells. Cæcum and colon normal. Lymphatic glands normal in size. The membranes covering the brain presented an arborescent appearance from the injection of the blood vessels. A slight hemorrhage on the left hemisphere near the longitudinal fissure. Considerable pigment over the frontal lobes. No fluid in the left lateral ventricle. A small quantity of blood-stained serum in the right lateral ventricle. Choroid plexus deeply injected.

A microscopic examination showed the blood and organs to be apparently normal. Tubes of culture media were inoculated with pieces of the liver, spleen, and kidney. Those inoculated from the spleen and kidney remained clear. One of the agar tubes inoculated with the liver developed into a culture of a motile bacillus. Unfortunately this culture was inadvertently rejected.

COMPARATIVE INOCULATIONS.

The positive diagnosis of rabies was not made until the results of a series of inoculations with the virus obtained from steer No. 4 were obtained and carefully compared with those of a parallel series with virus obtained from a rabid dog. As previously stated, the brain of steer No. 4 was carefully removed, placed in pure glycerin, and shipped by express to the laboratory at Washington, D. C., where it was received four days later. It was kept in a refrigerator for five days, when Dr. Theobald Smith made, from a portion of the medulla, a suspension in peptonized beef broth and injected about 0.24 c. c. beneath the dura of rabbit No. 398. This rabbit died in about seven weeks with symptoms of paralytic rabies. Two rabbits inoculated with an emulsion prepared from a piece of the brain of rabbit No. 398 subsequently died with similar symptoms. The series of inoculations thus begun extended over a period of nearly seven months, in which eleven rabbits were used, all of which died with symptoms of paralytic rabies.

Although comparative inoculations were made in several rabbits and calves which were carefully watched during the disease and examined post-mortem with the greatest care, there was not present any constant condition or conditions which enabled one to detect a difference between the diseases produced by the virus from different sources. The essential data obtained in these inoculations are here given.

INOCULATIONS WITH THE VIRUS ORIGINALLY OBTAINED FROM STEER NO. 4.

Rabbits and calves were inoculated with this virus beneath the dura, intravenously, and into the subcutaneous tissue. The data important from the diagnostic standpoint was obtained from the intracranial inoculations. The other methods were usually ineffective, although a few fatal results were obtained by the subcutaneous process. Attention is called particularly to the symptoms manifested by the different rabbits and the uniformity in the time between inoculation and death. The long period of incubation in the first rabbit inoculated was presumably due to the length of time the brain remained in the glycerin prior to its use. The number of rabbits used for subdural inoculation, the date of inoculation and death, are given in tabulated form. The symptoms and post-mortem notes for each animal follow the table.

A.—*Subdural inoculations in rabbits.*

Rabbit No —	Virus used.	Date of inoculation.	Date of death.	Period of time rabbits lived after inoculation.
				Days.
398	Brain of steer No. 4	Dec. 3, 1892	Jan. 18, 1893	46
420	Brain of rabbit No. 398	Jan. 18, 1893	Feb. 6, 1893	19
418	....do	....do	....do	19
424	Brain of rabbit No. 420	Feb. 9, 1893	Mar. 5, 1893	24
433	Brain of rabbit No. 424	Mar. 9, 1893	Mar. 31, 1893	22
434	....do	....do	Mar. 30, 1893	21
458	Brain of rabbit No. 434	Mar. 31, 1893	Apr. 19, 1893	20
496	Brain of rabbit No. 458	Apr. 21, 1893	May 9, 1893	18
9	Brain of rabbit No. 496	May 10, 1893	May 29, 1893	19
449	Brain of rabbit No. 9	June 3, 1893	June 24, 1893	21
56	Brain of rabbit No. 449	June 26, 1893	July 18, 1893	22

RABBIT NO. 398.

This rabbit remained well until January 16, forty-three days after its inoculation, when it became partially paralyzed in the hind limbs. There were no other signs of brain derangement. The rabbit ate sparingly of green cabbage.

January 17: The rabbit was found lying on one side feebly moving the forelegs, gasping as if dying. This condition continued all day.

January 18: Rabbit found dead. Subcutaneous veins filled with tarry blood; marked venous injection of the intestines. Cortex of the kidney and the base of pyramids pale, the remaining portion of a deep reddish color. Liver pale; spleen barely enlarged. Lungs pale. Heart contained tarry blood. The brain surface was marked with injected blood vessels.

RABBIT NO. 420.

Paralysis observed February 2, fifteen days after inoculation. It was unable to move its hind limbs, but dragged itself along with the forefeet.

February 3: Rabbit sat in its cage with both hind feet extended backward. Its eyes had a peculiar staring look. It smelled of food when presented, but refused to eat.

February 4: The symptoms were aggravated since yesterday.

February 5: Rabbit on one side breathed regularly.

February 6: Found dead in the morning. Membrane of the brain slightly injected; the gray and white matter normal in appearance; ventricles normal. Spinal cord not visibly affected. Lungs hyperæmic. Heart normal in color. The liver very dark; a microscopic examination showed a large amount of pigment. Spleen and kidneys normal. Slight venous injection of intestines. Tubes of agar inoculated from the various organs remained clear. Cover-glass preparations showed no microorganisms.

RABBIT NO. 418.

Exhibited the same symptoms as rabbit No. 420. The post-mortem showed a marked hyperæmia of the kidneys, otherwise not different from No. 420.

RABBIT NO. 424.

March 2, twenty-one days after its inoculation, this rabbit was paralyzed in the hind limbs; could barely drag himself a few inches by using forefeet. Ate very little. Hitherto he appeared to be perfectly well.

March 3: Rabbit could not use his hind feet; otherwise appeared to be better than yesterday.

March 4: Rabbit was sitting up in usual position; paralysis much improved, but appeared to be in distress.

March 5: Rabbit found dead. The liver was very dark, containing pigment. Heart muscle unusually pale. Lungs slightly congested. The brain appeared to be normal

RABBIT NO. 433.

March 29: Twenty days after inoculation this rabbit appeared to be dull, but when placed on the floor would hop about slowly.

May 9: Head drawn back. Respiration slow. Died about 2 p. m. Mouth and fauces normal. Stomach contained partially digested food. Liver deeply reddened; contained much blood and pigment. Spleen normal. Kidneys pale, parenchymatous degeneration of cortex. Heart muscle unusually large; blood vessels injected. Lungs hyperæmic. The brain appeared to be normal.

RABBIT NO. 9.

This rabbit exhibited its first sign of the disease on the sixteenth day. Its temperature was taken daily at 8 a. m. For the first sixteen days it was normal excepting on the ninth, twelfth, and fifteenth days, when it reached 104.8°, 104°, and 104.2° F., respectively.

May 26 (sixteenth day): Temperature 102.2° F. Rabbit had difficulty in using hind legs.

May 27: Temperature 101.5° F. Partial paralysis of hind legs in the afternoon.

May 28: Temperature 89.8° F. Lay on one side, but was able to move all four feet. Respiration slow but easy. Head was drawn slightly backward.

May 29: Rabbit unconscious. No reflex movement when touched. Respiration very slow. It died about 11 a. m. Mouth and pharynx normal. The blood vessels of the trachea slightly injected. In cephalic lobe of right lung there was a small necrotic area. The blood vessels of heart slightly injected. Lungs hyperæmic. Liver dark, containing much pigment. Kidneys pale, especially cortex. Brain normal in appearance.

RABBIT NO. 449.

Fifteenth day: The temperature on the ninth day was 104.8° F. On the following day it was 103.8°; subsequently it was normal. The first symptom noticed was a marked inclination to sit close in one corner of the cage and to refuse to move.

June 20 (seventeenth day): Rabbit considerably excited; respiration accelerated. A noticeable loss of coordination in the hind limbs. Temperature 102.8° F. In the evening rabbit lay on one side unable to rise. When touched it moved its forefeet slightly.

June 21: Rabbit unable to move its feet. The head moved a little. Respiration easy. In the evening a slight tapping on its cage induced a feeble movement of the head. Otherwise paralyzed.

June 22: Rabbit remained the same as yesterday.

June 23: Respiration labored. A very slight movement of the head when the cage was tapped. A few movements of the lower jaw noticed.

June 24: No change from yesterday. When turned over a slight movement of the head noticed. Head drawn backward. Rabbit died about 6 p. m. Liver deeply reddened. Brain normal in appearance.

RABBIT NO. 434.

This rabbit remained well for several days, when it showed signs of paralysis.

March 29: Rabbit appeared dull, moved only after much urging, and had very little use of hind legs. It failed rapidly during the morning. At 11 a. m. it was barely able to sit up; hind legs projected backward. At 4 p. m. it lay on one side; no movement of body visible, except slow respiration and occasional twitching of forefeet and nose.

March 30: Rabbit found dead in the morning.

The mouth and fauces normal in appearance. The liver much enlarged and engorged with blood. Examination showed much pigment. The spleen slightly enlarged and very dark colored. Heart muscle pale. Lungs hyperæmic. The blood vessels of the brain injected, giving the gray matter a faint pinkish tint. Ventricles normal in appearance.

RABBIT NO. 458.

Rabbit appeared to be well for fourteen days. It then exhibited marked emaciation and scratched the bottom of its cage almost continuously. These symptoms continued for four days, when the rabbit was found lying on one side as if in a semicomatose condition. A little later it was observed climbing about the cage and could walk without falling. A few hours later it was lying on one side. When disturbed it moved all four feet, but made no other effort to rise. Two hours later it was apparently unconscious. When touched with a stick it moved the forefeet very little and lay on one side as before. No visible change on the following morning, except that the respiratory movements were much more feeble. It died early in the evening.

Mouth and fauces normal. Blood vessels of heart and lungs hyperæmic. The liver very dark, containing much pigment. Brain appeared to be normal.

RABBIT NO. 496.

This rabbit remained well for fourteen days. May 5 (the fourteenth day) it sat in one corner of its cage. When disturbed it showed slight nervousness, and if forced to move was uncertain in its steps; toward night movements became difficult—unable to walk naturally.

Mouth and pharynx normal. Liver deeply congested. Brain normal in appearance, except that at the point of inoculation there was a yellowish necrosed area about as large as a pin's head. No other lesions.

RABBIT NO. 56.

On the twentieth day after inoculation the rabbit exhibited peculiar movements when disturbed; on the following morning it was partially paralyzed in the hind limbs. In the afternoon paralysis became complete in all four limbs. It lay on its abdomen with the head turned to the left. It remained in this position for about twenty-four hours, when it died. Liver very dark, otherwise organs appeared to be normal.

B.—*Inoculation of cattle.*

Animal number.	Virus used.	Method of inoculation.	Date of inoculation.	Date of death.	Time from inoculation until death.
Calf No. 19[*]	Brain of steer No. 3	Beneath dura	Nov. 20, 1892	Dec. 19, 1892	29 days.
Calf No. 239[†]	Brain of rabbit No. 424.	Subcutaneously right side of neck. 2 c. c. of emulsion.	Mar. 7, 1893	Apr. 6, 1893	30 days.
Yearling No. 241	Suspension, brain of rabbit No. 424.	Beneath dura, 0.10 c. c.	.....do	Mar. 26, 1893	19 days.
Yearling No. 242	.....do	.....do	.....do	.....do	19 days.
Calf No. 238	Filtrate, brain suspension, yearling No. 242.	.....do	Mar. 27, 1893	....	Remained well.
Yearling No. 238	Suspension, brain of yearling No. 242.	.....do	.....do	Apr. 14, 1893	18 days.
Yearling No 249	Suspension, brain of rabbit No. 436.	Subcutaneously 0.3 c. c.	May 10, 1893	....	Remained well.

[*] For notes see page 76.

[†] The calves were from 6 to 8 months old.

YEARLING NO. 241.

Female. Inoculated beneath dura with 1 c. c. of an emulsion of the brain of rabbit No. 424, March 7. She remained apparently well for fifteen days. March 22 she refused food and water. She was very uneasy, pressed her head vigorously against the sides of the stall, bellowed very frequently, more especially when a person was in sight. At times she pawed and stamped with the forefeet. On opening the door of the pen she made vigorous efforts to escape and did not notice either words or whip. In the yard she followed a person, pressing her nose forcibly against him, but not viciously. The bowels had been loose for two days (this was thought to have been due to the food given). Temperature, 103.8° F., taken every day at 8 a. m. Slight dribbling of saliva.

March 23: She ate and drank very little; temperature 100.3° F.; considerable diarrhea. Very uneasy; bellowed frequently. No rumination.

March 24: Temperature 102° F. Animal continued to press her head against the side of the stall, bellowing almost continuously. The presence of a dog produced no effect. Diarrhea continued; considerable tenesmus. She laid down frequently, often rose immediately, but at times would lie quietly for some minutes.

March 26: Temperature 99° F. Animal lying down, unable to get up. She died about 4 p. m.

Autopsy made March 27.—Post-mortem changes somewhat advanced. The intestinal tract appeared to be normal, excepting a few punctiform hemorrhages in pyloric portion of the stomach. Spleen normal. Liver and kidneys slightly discolored from decomposition. No lesions determined. Hypostatic congestion of right lung. Considerable œdema about the heart. There were about 400 c. c. of a clear, dark, wine-colored liquid in the pericardial sac. No hemorrhages in the heart muscle, which was of a bluish color. Ventricles empty, dark blood clots in both auricles. The brain was somewhat soft, apparently due to post-mortem changes, otherwise normal in appearance.

CALF NO. 239.

Female. The animal remained apparently perfectly well until April 1, twenty-four days after its inoculation. On that day it refused all food. Small drops of perspiration had collected thickly on the hairs on the dorsal aspect of the body. Each breath was accompanied by a slight moan. The entire body in a tremble. Temperature 104.5° F., which hitherto has been normal.

April 2: Temperature 103.2° F. Refused food. Bellowed frequently without apparent cause. When approached she presented a surprised appearance, head elevated. In the evening she followed other calves, frothing at the mouth.

April 3: Temperature 103.8° F. Trembling of the entire body; stood with head erect, bellowing occasionally. When walking showed a marked loss of coordination in the hind legs, with unsteadiness in forefeet; considerable swaying from side to side. The forefeet were placed outward in a bracing position. Later in the day walking became impossible and she lay on one side, unable to get up.

April 4: Temperature 100.5° F. Lay on one side, with legs extended and head drawn backward. When approached slight movement of limbs and faint bleating; refused food, but drank about 3 quarts of water. Temperature in evening, 98.2° F.

April 5: Temperature 96.2° F. Lay perfectly quiet; no movement of body; raised head slightly when approached. Refused all food and water. Offered no resistance in being rolled over. Head drawn backward much more than normal. No retraction of the eyeballs; no trembling or twitching of the muscles. Toward night there was apparently complete paralysis.

April 6: Calf found dead early in the morning.

Autopsy.—Weight about 250 pounds. Condition good. The calf has lost very little flesh during sickness. When skinned considerable dark blood oozed from the cut ends of the veins. The spleen was much enlarged and dark colored, the normal markings nearly all obliterated. The blood vessels in the capsules injected. The liver was slightly enlarged. Capillaries filled with blood, which flowed freely upon section. Many of the liver cells in a state of fatty degeneration. The gall bladder contained about 100 c. c. of thick greenish, slightly viscid bile holding flaky mucus in suspension. A slight congestion of the cortex of the kidneys, tubular epithelium granular, otherwise normal. Lymphatics normal in appearance.

The mouth, pharynx, larynx, and œsophagus normal. The rumen contained considerable rather dry food. The omasum contained a normal quantity of food. The abomasum was empty, and the mucosa, excepting in the pyloric portion, deeply reddened. The mucosa of the duodenum deeply reddened with a few hemorrhagic areas and the contents blood stained. The mucosa of the jejunum and ileum sprinkled with small hemorrhagic areas. Contents blood stained. Cæcum and colon nearly empty, the mucosa covered with a thin layer of whitish somewhat viscid mucus.

The trachea and bronchioles contained very little mucus. The cephalic lobes emphysematous. The entire lungs had a bluish red color due to capillary injection. Upon section a small quantity of blood-stained serum oozed out of the cut vessels. A few punctiform hemorrhages on the pericardium. In left ventricle and auricle were firm dark clots which extend into the large blood vessels. In right side of heart were small clots also extending into larger blood vessels. The brain showed considerable pigment over frontal lobes. The blood vessels injected, especially in choroid plexus. Upon section small drops of blood oozed from the cut vessels. Ventricles normal. In certain of the cells from the gray matter peculiar highly refractive bodies were observed in the cellular protoplasm, outside of the nuclei. They were not observed to move in the myelinic fibers. In a few instances these bodies appeared to move. The spinal cord seemed to be normal.

A large number of tubes of agar were inoculated with brain tissue from various parts of that organ and with pieces of the other organs of the body. In one tube inoculated with the blood a few cultures of a streptococcus were obtained. It possessed no pathogenic effect on mice. All of the other inoculated tubes remained clear.

YEARLING NO. 242.

Inoculated with an emulsion of a bit of the brain of No. 241. It manifested precisely the same symptoms as No. 241, but died about sixteen hours sooner. Its temperature varied from 100.8° F. to 103° F. for the first fifteen days. The last four days it was 102.6°, 103.8°, 103.8°, and 103.6°, respectively. The autopsy showed lesions similar to those found in No. 241. No bacteria were discovered in the organs.

CALF No. 247.

A heifer about ten months old. Inoculated March 7. She remained well until April 7, when she refused food; otherwise no symptoms noticeable until April 11, when she had paroxysms of bellowing, and hooked and pawed her bedding considerably. Upon being approached she manifested a marked desire to press her nose against the individual. Temperature normal. She drank occassionally from a bucket of water in the stall. These symptoms continued for two days without change. There was a rapid loss of flesh.

April 13: In the morning she was noticed to froth at the mouth slightly and to be much more restless; bellowed frequently, but was not disturbed by the presence of a person. She occasionly drank a few swallows of water. Temperature 103.5° F. The eyes were normal in appearance. Considerable perspiration.

April 14: Heifer found dead in the morning. Examined about 2 p. m. The post-mortem changes considerably advanced. Areas of deeply reddened mucosa in the true stomach and intestines, especially cæcum and upper colon. Considerable whitish froth in trachea and bronchioles. Lungs not collapsed. About the base of the heart and along ventricular groove were many petechiæ. Large, firm blood clots in both ventricles and auricles extending into the larger blood vessels. No lesions observable in the brain. The gray matter was somewhat softened, due presumably to post-mortem changes.

INOCULATION OF RABBITS AND A CALF WITH THE BRAIN OF A RABID DOG.

The virus for this series of inoculations was obtained from a rabid dog brought to the experiment station by Dr. Grenfell, of Washington, D. C., March 22, 1893. It had been affected for about three days and was killed the day following its arrival. A calf and two rabbits were inoculated by Dr. F. L. Kilborne with a suspension prepared by grinding a small portion of the medulla with a few cubic centimeters of sterilized bouillon. The calf and one rabbit were inoculated beneath the dura; the other rabbit was injected subcutaneously. In addition to these inoculations several others were made for diagnostic purposes from the brains of dogs suspected of rabies, or reported to be suffering from it. A considerable number of these died after exhibiting symptoms similar to those produced in animals after their inoculation with the brain of the dog first mentioned and which are recognized as diagnostic for rabies.

The more important data obtained in these inoculations are recorded in tabulated form, followed by a detailed account of the symptoms, and the lesions found in the different animals on post-mortem examination:

Inoculation of animals with the brains of rabid dogs.

Animals.	Virus used.	Method of inoculation.	Date of inoculation.	Date of death.	Period of inoculation.
					Days.
Rabbit No. 448	Brain of rabid dog No. 1	Beneath dura	Mar. 24, 1893	Apr. 6, 1893	13
Rabbit No. 447	do	Subcutaneously	do	Apr. 20, 1893	27
Rabbit No. 495	Brain of rabbit No. 447	Beneath dura	Apr. 21, 1893	May 2, 1893	11
Rabbit No. 481	Brain of rabid dog No. 2	do	Apr. 11, 1893	Apr. 28, 1893	17
Rabbit No. 50	Brain of rabid dog No. 3	do	June 20, 1893	July 8, 1893	18
Calf No. 246	Brain of rabid dog No. 1	do	Mar. 24, 1893	Apr. 3, 1893	10

RABBIT No. 448.

Inoculated beneath the dura with about 0.2 c. c. of an emulsion of the brain of a rabid dog, March 24, 1893.

April 4: Rabbit sat in one corner of its cage. When disturbed its skin quivered and it appeared to be excited; apparent loss of coordination; refused fresh green food.

April 5: Rabbit quiet. When disturbed it moved with difficulty. Eyes partially closed. It was rolled over on one side, when it struggled feebly to get up, but failed.

April 6: Rabbit paralyzed. Lay stretched out at full length, apparently dead; respiration very slow. It died later in the day.

Autopsy showed deeply reddened liver; blood vessels of the brain slightly injected; no other lesions.

RABBIT No. 447.

Inoculated subcutaneously with a suspension of brain of rabid dog (same as rabbit No. 448), March 24.

April 21: Rabbit found dead. Was not observed to be sick prior to death.

Autopsy showed a deeply reddened liver, due to blood stasis. Lungs partially collapsed. Brain anæmic. In order to determine the presence of rabies in this rabbit its brain was used for a subsequent inoculation which produced characteristic symptoms of rabies and fatal results.

RABBIT No. 495.

This rabbit remained well for eight days.

April 29: It exhibited unsteadiness in walking. Temperature 103.8° F.

April 30: Loss of coordination, especially in hind legs. Temperature 102.6° F.

May 1: Rabbit lay paralyzed on the bottom of its cage. Respiration rapid; pupils dilated and head drawn backward; later in the evening slow respiration was the only sign of life. Temperature 90° F.

May 2: Rabbit died about 7 a. m.

Autopsy.—Considerable viscid mucus in small intestines. In the ileum several small ulcers. Liver pale, very fatty. Blood vessels of the heart slightly injected. Mouth and fauces normal. Blood vessels of the brain slightly injected.

RABBIT No. 481.

This rabbit was inoculated with the brain of rabid dog No. 2.

April 27 (sixteen days after inoculation): The rabbit showed signs of paralysis in the hind legs early in the morning, but late in the afternoon the paralysis was nearly complete; respiration slow.

April 28: Complete paralysis. Very slight and slow respiratory movements. Rabbit died about 3 p. m.

Autopsy.—Much mucus in the small intestine. Liver very dark and contained much pigment. Mouth and pharynx normal in appearance. Blood vessels of the brain somewhat injected.

RABBIT No. 50.

This rabbit was inoculated with the brain of rabid dog No. 3. No symptoms observed until July 6 (sixteen days after inoculation), when it appeared to be uneasy; later in the day there was marked loss of coordination in the use of the hind legs.

July 7: Rabbit lay on the floor of the cage, unable to rise. Slight twitching of muscles when disturbed.

July 8: Complete paralysis. Respiratory movements barely perceptible. It died late in the afternoon.

Autopsy.—Liver dark, otherwise organs appeared to be normal.

CALF NO. 246.

This animal was inoculated beneath the dura with a suspension of the brain from rabid dog No. 1, March 24, 1893.

April 2: Calf was uneasy, eyeballs retracted, considerable frothing at the mouth. When approached it bellowed and endeavored to escape from the pen, seeming to be frightened. Temperature 101.8° F.

April 3: Calf became much excited while taking its temperature, which was accomplished after much difficulty, 105.4° F. being recorded. Calf had symptoms of convulsions; laid on one side; considerable trembling of muscles, and the head drawn back. Later it became partially paralyzed. Evacuation of bowels normal. It died early in the afternoon.

Autopsy.—Weight about 275 pounds; condition fairly good. Intestinal tract apparently normal throughout. Heart muscle sprinkled with a few punctiform hemorrhages. Dark blood clots in each of the heart chambers. Petechiæ beneath pleura over both lungs, considerable frothy mucus in the trachea and bronchioles. At the point of inoculation in the brain there was a slight necrosis of tissue, blood vessels slightly injected, otherwise brain and spinal cord normal in appearance. A rabbit inoculated with the brain from this calf died of rabies on the twelfth day subsequently.

The foregoing notes on the manifestation of the disease produced by the virus obtained from steer No. 4 in the Greene outbreak and from the brains of rabid dogs in the District of Columbia show that the inoculation diseases were identical. It has already been shown that the disease produced in rabbits with the brain of the steer was readily communicated to cattle by inoculation with the virus obtained from the affected rabbits, and, furthermore, the symptoms of the inoculated disease in the calves were similar to those manifested by the cattle which died in Mr. Wade's herd. A study of the symptoms shows that partial paralysis was usually the first indication of the disease. The average length of time which elapsed from the appearance of the first symptoms until death occurred was practically the same in both instances, but the average period of incubation was appreciably shorter in the rabbits inoculated with the dog virus.

The post-mortem appearances were practically the same in all cases; at least the differences observed in two animals inoculated with the same virus were quite as marked as those observed in rabbits inoculated with the virus from the different sources. It is important to note that the mouth, larynx, and intestinal tract usually presented a normal appearance. The enlarged and deeply reddened condition of the livers which contained much pigment was the only constant lesion observed.

The positive diagnosis of rabies, or a malady not distinguishable from it, in this outbreak of cattle disease is of much importance. As the animals were not furious the possibility of rabies was not entertained by the owner who had witnessed the furious form of the disease produced by the bite of rabid dogs.

This determination is furthermore significant in throwing light upon the probable nature of other outbreaks of a somewhat mysterious disease among cattle occasionally reported in the Western States. The most serious of these on record is an outbreak which occurred in a herd of cattle pasturing on the bottom lands along the Des Moines River near Emmetsburg, Iowa, in 1891. Dr. Stalker tells me that the symptoms manifested and the post-mortem appearance of the affected animals in the two outbreaks were similar in every particular. Unfortunately rabbits were not inoculated with the brains from the animals examined at Emmetsburg. It is interesting to compare the conditions under which the two outbreaks occurred. In both cases the presence of rabid or strange dogs was not known. The cattle in the two affected herds were on lowland, better known, perhaps, as "slough" pasture. Although Mr. Wade's cattle were furnished well water, it is highly probable that the animals drank more or less of the stagnant water which remained throughout the season in pools between the bogs, as they were never driven from the lowlands to the watering trough. In the affected herd at Emmetsburg it is stated that the cattle were compelled to drink exclusively from a pond of stagnant water. It is a curious and most interesting fact that there were two other herds of cattle on the bottom lands of the Des Moines River at the same time, but they were driven daily to the river for water, and these two herds remained free from the disease. While the known facts in these outbreaks in no way demonstrate their identity, they suggest a striking similarity between them and indicate a possible relationship between the conditions under which the cattle were kept and the disease.

Until the specific cause of rabies is demonstrated we are able to recognize the virus in the brain substance of the affected animals only by its ability to reproduce the disease when properly inoculated into other animals. As shown in the inoculation experiments, the filtrate (through a bougie of a Pasteur filter) of a suspension of the brain substance of a rabid animal would not produce the disease, while the injection of the suspension was followed by characteristic symptoms and fatal results. This fact, which confirms the results of other investigators, indicates that the specific cause is not a soluble substance. The extensive bacteriological investigations made by several European workers indicate that the virus of rabies is not bacterial in its nature, and the presence of other microscopic organisms have likewise not been demonstrated. Several interesting facts concerning the nature of rabies were noted during the course of this investigation, but as they do not pertain to the diagnosis of the disease in this outbreak among cattle they are withheld for a future publication.

The results of this series of investigations indicate that rabies, or a closely related disease, sometimes occurs among cattle kept under certain conditions without the intervention of rabid dogs or other animals. A review of the voluminous literature on rabies shows that many supposed sporadic cases are recorded, and also considerable evidence that the bites of several species of animals have produced the disease. Until the specific cause of this malady is determined it is suggested that cattle raisers should consider the possibility of its occurrence when they turn their cattle upon low, boggy pasture land.

Although a remedy is not known it is quite probable that if the animals are removed to high land as soon as the first deaths occur the amount of loss will be much less than if they are allowed to remain on the lowland throughout the season, especially when the disease appears early in the summer. This is indicated by the history of the outbreaks cited. Mr. Wade's cattle were removed early in the fall and the loss was only about 30 per cent, while at Emmetsburg it is stated that the cattle were not taken up until late in the fall, and the loss was very much greater.

LETTER OF SUBMITTAL.

SIR: I herewith submit the result of the examination of cornstalks supposed to be the cause of disease in cattle.

Respectfully,
E. A. DE SCHWEINITZ,
Chemist, Biochemic Laboratory, B. A. I.

DR. D. E. SALMON,
Chief of Bureau of Animal Industry.

CHEMICAL EXAMINATION OF CORNSTALKS PRESUMABLY THE CAUSE OF CORNSTALK DISEASE IN CATTLE.

By E. A. DE SCHWEINITZ.

In 1890 some cornstalks were brought to the laboratory for examination. These had been collected from a field in which a few cattle had died from the so-called cornstalk disease, and were supposed to be the cause of the fatal result. The leaves and stalks were covered with smut. This was carefully separated before the examinations were made. An extract from the stalks gave reactions which would indicate the presence of cholin. Although this has been found in a number of plants, so far as I know it has never been noted in this connection, nor was the quantity present sufficient to have produced any poisonous effects in animals feeding on the stalks.

In 1892 and 1893 Dr. Moore undertook a more extended study of the cornstalk disease in the field, and collected and forwarded for study several packages of stalks. These were examined by Mr. Emery, under my direction. The dried powdered stalks were first extracted with petroleum spirits, and the residue then extracted with alcohol acidified with 3 per cent hydrochloric acid. This extract upon evaporation was slightly charred, but the water extract of the residue gave a yellowish green precipitate with phosphomolybdic acid. The water solution was then made alkaline with soda and extracted with ether, but no reaction for alkaloids could be detected. The solution made acid and again shaken with ether gave a small quantity of a brown, oily substance. The latter, however, gave no alkaloid reactions and failed to produce any effect upon guinea pigs when fed to them in considerable quantity. The petroleum extract was also free from poisonous principles. Another lot of stalks, leaves, and a few ears of corn collected from a portion of a field where animals had become ill were examined. The stalks, husks, and kernels of this lot were all examined for alkaloids or poisonous principles, but failed to show any reactions, with the exception of a slight precipitate with phosphomolybdic acid.

Some corn smut carefully separated from the above leaves and stalks was next extracted with alcohol acidified with hydrochloric acid. The extract was concentrated, neutralized with soda, and shaken with ether. The ether extract was evaporated spontaneously and the residue taken up with acidified water. The following reactions were obtained in this solution:

Iodine in potassium iodide, a red-brown amorphous precipitate.
Phosphomolybdic acid, a dirty yellow amorphous precipitate.
Mayer's solution, a whitish amorphous precipitate.

The solution was then neutralized with soda extracted with ether, and the latter solution concentrated over sulphuric acid in vacuo. A very small quantity of an oily nonpoisonous residue was obtained.

Some of the leaves sent in by Dr. Moore were covered with dark spots due to a parasitic disease. The diseased portions were carefully cut out and examined for alkaloids or poisonous principles.

The oily residue from the smut and also that from this part of the stalks appeared to correspond to sclerotic acid, a principle which Dragendorff has extracted from ergot and which Parsons claims to have found also in ustilago (corn smut). The quantity, however, obtained from the stalk would not be enough to account for the fatal effects in cattle unless a peculiarly susceptible condition of the animal existed at the time, or the improbable supposition that an excessively large amount of the poison was contained in the leaves and stalks that the animal happened to eat.

An enlarged and badly congested liver was also forwarded by Dr. Moore. This had been taken from one of the animals that had died supposedly from the cornstalk disease.

The liver was extracted with 90 per cent alcohol plus 20 per cent tartaric acid and the filtrate was evaporated in a vacuum pan. The residue was extracted with 95 per cent alcohol, and after reevaporation the residue was extracted with water. The solution gave a slight precipitate with phosphomolybdic and phosphotungstic acids, but no other alkaloidal reagents. The solution was then concentrated and mercuric chloride added in excess. After standing several days a precipitate was thrown down. This was filtered off and decomposed with sulphuretted hydrogen. After the mercury had been separated the residual solution gave a white curdy precipitate with phosphomolybdic acid. The filtrate from the mercuric chloride precipitate gave no reaction with alkaloidal reagents. The solution which gave a precipitate with phosphomolybdic acid was made alkaline with sodium hydrate and extracted with ether and chloroform. The water solution of the residue from these solvents gave a slight precipitate with phosphomolybdic acid but with no other reagent. It is true that this is the only reagent that gives a distinctive precipitate with sclerotic acid, but the precipitate here could scarcely be supposed to be due to the presence of this substance. The results of these examinations must be considered negative in character so far as the presence of an active poisonous principle is concerned.

The determination of the amount of ash in the cornstalks showed in the dry matter 6.4 per cent, and an examination was made for possible excessive quantities of nitrates.

Recently cattle have been found poisoned from cornstalks containing an unusual amount of potassium nitrate (Bulletin No. 44, Kansas experiment station). In the stalks, however, in which this was found the potassium nitrate could be detected by the eye in large crystals, and also by the taste. The particular stalks had been grown under peculiar conditions near the barn, where excessive amounts of nitrates could be absorbed. Those that we examined contained only a minute trace of the nitrate, so that if in any of the instances the cornstalks were the cause of disease in the cattle, and our samples were fair specimens, the poisoning was not by this salt. It should be remembered, however, that in all our examinations of the stalks the quantity used was small and not proportional to the amount cattle would eat. An apparently nontoxic principle under peculiar conditions might produce disasterous results.

INDEX.

Page.

- *Aspergillus glaucus* 49
- Bacteria in affected animals 58
  - cultures in blood 58
  - diseased cornstalks 40, 41
- *Bacillus cloacæ* 45
  - description 46
  - in cornstalks 40, 48
    - soil 45
- *Bacillus coli communis* 21, 76
- *Bacillus fluorescens liquefaciens* 73
- Billings, Dr. F. S 10, 13, 57, 62
- Burrill, Prof T. J 15, 39, 45, 59
- Calves inoculated with rabies 76
  - virus from cattle 76
    - dogs 83
- Cattle disease at Emmetsburg 86
- Chemical analyses 49
- Cholin, occurrence in cornstalks 88
- Corn blight or the Burrill disease of corn 39
  - effect of fertilizers 41
  - rabbits fed on affected cornstalks 42
- Cornstalk disease in cattle 9
  - conditions under which it occurs 50
  - economic importance 62
  - etiology 10, 59
  - geographic distribution 9
  - history 9
  - hogs fed upon carcasses of diseased cattle 28
  - investigations by Billings 13
    - Gamgee 10
    - Illinois Experiment Station 15
  - nature 9
  - outbreaks 20
  - pathology 12, 55
  - prevention 64
  - symptoms 9, 11, 53
- Cornstalks as food for cattle 10
  - cholin, occurrence 88
- Enteritis in cattle 60
- *Enzootic cerebritis* 49
- Farmers' Review, summary of reports of prevalence of cornstalk disease 63
- Gamgee, Prof. John, indorsement of smut theory 10
- Going, Dr., investigations 60
- Hay, Leon, investigations 41
- Horses in cornstalk fields 34

Page.
Impaction, cause of death in cattle fed on dry food ... 57, 60
Kilborne, Dr. F. L., investigations and experiments ... 20, 23, 30, 44, 47, 83
Letter of inquiry, object ... 16
Mayo, Dr. N. S., description of a disease in horses ... 49
  cattle poisoned, potassium nitrate ... 61
McClure, Professor, observations on dwarfed corn ... 41
Niles, Dr. W. B., assistance in post-mortem examinations ... 19, 23, 27, 59
Nocard, Professor, isolation of bacillus of bovine pneumonia ... 14
Potassium nitrate ... 61, 89
  cattle poisoned ... 61
  occurrence in cornstalks ... 61
Pneumonia, relation to cornstalk disease ... 57
Rabbits inoculated with cornstalk disease, immunity ... 39
  rabies, effect ... 73
  virus from cattle, experiments ... 73, 78
  dogs, results ... 83
Rabies, comparison with other diseases in cattle ... 71
  history of outbreak in cattle ... 71
  lesions ... 73
  symptoms ... 72
  in dogs ... 83
Russell, H. L., investigations of bacteria in living plant tissue ... 47
Sclerotic acid, occurrence ... 89
  tests ... 89
Schroeder, Dr. E. C., observation ... 64
Schweinitz, Dr. E. A. de, chemical examination of cornstalks ... 49, 88
Sheep in cornstalk fields ... 28
Smith, Dr. Theobald, inoculation experiments ... 45, 77
Stalker, Dr. M., investigations ... 19, 71, 86
Toxæmia maidis ... 9, 62
Ustilago maidis ... 10, 18, 47
  feeding cattle with ... 47
Wade, John, experiments on farm ... 71

BULLETIN NO. 11. (Dairy No. 1.)

U. S. DEPARTMENT OF AGRICULTURE.
BUREAU OF ANIMAL INDUSTRY.

STATISTICS OF THE DAIRY.

COMPILED FROM THE UNITED STATES CENSUS FOR 1890,
AND FROM OTHER RELIABLE SOURCES,
WITH EXPLANATORY NOTES,

BY

HENRY E. ALVORD, C. E.,
CHIEF OF THE DAIRY DIVISION.

Under the direction of
Dr. D. E. SALMON,
Chief of the Bureau of Animal Industry

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1896.

LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY,
Washington, D. C., December 7, 1895.

SIR: I have the honor to transmit herewith for publication a report of Maj. H. E. Alvord, Chief of the Dairy Division of this Bureau, covering the principal statistics relating to the dairy industry of the United States. The subject is an important one, and there is here brought together for the first time the statistical information which shows the development and the magnitude of this branch of American agricultural effort. It is information which every intelligent dairyman needs, and it is also designed as the foundation for much of the future work of the Dairy Division. Its prompt publication in an available form will be of much benefit to an industry which at this time is in great need of assistance.

Very respectfully,

D. E. SALMON,
Chief of Bureau.

HON. J. STERLING MORTON,
Secretary of Agriculture.

LETTER OF SUBMITTAL.

U. S. Department of Agriculture,
Bureau of Animal Industry, Dairy Division,
Washington, D. C., November 21, 1895.

Sir: I have the honor to submit herewith for publication a compilation of the principal statistics relating to the dairy industry of this country, constituting the first publication of this division.

A part of the figures thus brought together are easily found, but, on the other hand, many of them are inaccessible to people generally. It is believed that the collection as presented will prove interesting and useful to many persons connected with dairying and form a suitable basis for future publications prepared by this division.

It is disappointing to find little data available as to the dairy interests of foreign countries. About all that can be obtained are the number of cows and other cattle. With a few exceptions, products are mere matters of estimate. Statistics of foreign markets for dairy products can be obtained, but these, together with the whole subject of exports, imports, and domestic markets, are reserved for a subsequent publication.

Yours, respectfully,

Henry E. Alvord,
Chief of Dairy Division.

Dr. D. E. Salmon,
Chief of the Bureau of Animal Industry.

CONTENTS.

	Page.
Introductory. By Henry E. Alvord	7
Object and purpose of the division	7
Census and other statistics	7
Neat cattle on ranges	8
Cows on farms not all dairy cattle	9
Cows in cities, towns, and villages	9
Relative importance of the dairy	9
Estimate for 1895	9
Needed improvement in dairy cattle	10
Discussion of the agricultural statistics of the Eleventh Census. By John Hyde	12
Neat cattle	12
Statistics of quality	13
Milch cows on farms	14
Dairy products	17
Milk production	17
Butter production on farms	18
Production of cheese on farms	21
General agricultural statistics	23
Table I. Farm and dairy statistics of the United States	23
Table II. Dairy statistics by States	26
Table III. Progress of dairying in the United States	28
Table IV. Butter, cheese, and condensed milk factories, including all creameries	33
Table V. Number and value of milch cows in the United States, and of other farm animals, yearly, 1870 to 1895, inclusive	34
Table VI. Cattle statistics (additional) by States	35
Table VII. Farm statistics by States	37
Cows and cattle of foreign countries. By R. A. Pearson	38
Table VIII. Cows and cattle of foreign countries for stated years	42
Table IX. Population and number of cows per square mile of land surface in each State and Territory in 1890	43
Table X. Pounds of cheese and butter produced per square mile of land surface in each State and Territory in 1889	43
Table XI. Rank of each State and Territory in 1890 in regard to land area, population, etc	46
Table XII. Neat cattle on ranges in the United States	47
Table XIII. Average value of a cow in the United States for stated years.	47
Table XIV. Registered or pedigreed cattle of selected breeds in the United States and their values	47
Table XV. Growth of the factory system in the United States	47
Dairy statistics relating to several States later than 1890	49

ILLUSTRATIONS.

Page.
Diagram A. Relative values of principal farm products of the United States in 1859, 1879, and 1889 24
Diagram B. Cheese and butter production of the United States in 1890, by States, arranged according to rank 27
Diagram C. Cheese and butter production—five census years 32
Diagram D. Number of cows in each State and Territory, according to the Eleventh Census 36
Diagram E. Number of cows per square mile and per 20 persons in each State and Territory, 1890 44
Map of Iowa, with location of creameries 48

STATISTICS OF THE DAIRY.

By HENRY E. ALVORD, C. E., *Chief of Dairy Division.*

INTRODUCTORY.

OBJECT AND PURPOSE OF THE DIVISION.

The order establishing the Dairy Division in the Bureau of Animal Industry of the United States Department of Agriculture, to commence operations July 1, 1895, prescribes that "the object and purpose of this division will be to collect and disseminate information relating to the dairy industry of the United States, in such manner and to such extent as may be deemed most expedient and beneficial."

Information bearing upon dairying will be gathered from all reliable sources available, and classified and arranged at this office for future use. It is proposed to prepare publications of three classes: (1) Leaflets upon points in dairy practice, farm dairying, cooperative effort, organization, equipment, and management of creameries and cheese factories, and facilities for transportation and marketing; (2) bulletins upon dairy topics, somewhat more extended, giving latest information and most approved methods, gathered at home and abroad from expert dairymen, creameries, organizations, and the experiment stations and dairy schools; also, as to condition, changes, and needs of the dairy markets; (3) reports upon the results of special inquiries and investigations.

Among the subjects which will receive early attention and require considerable time are these: (1) The condition and demands of domestic markets for dairy products; (2) the milk trade; production and service for cities and towns; (3) imitations and substitutes for dairy products; and (4) the number and distribution of pure-bred dairy cattle and of grades, with their effects upon products and markets.

As a basis for intelligent work in the various lines indicated, it became necessary to gather and arrange the general facts as to dairying in statistical form. This bulletin has resulted from that endeavor.

CENSUS AND OTHER STATISTICS.

Upon the pages following are given most of the statistics which are available relating to the dairy in the United States, and some upon the or is sold to be consumed as milk, fresh or condensed. These estimates, with products and values added, may be tabulated as follows:

Cows.	Product.	Rate of product.	Total product.	Rate of value.	Total value.
Millions.					*Dollars.*
11	Butter ...	125 pounds....	1,375,000,000 lbs...	20 cents..	275,000,000
1	Cheese ...	280 pounds....	280,000,000 lbs...	8 cents..	22,400,000
5	Milk	350 gallons....	1,750,000,000 gals..	9 cents..	157,500,000

This gives the grand total value of the dairy products of the country as $454,900,000. If to this be added the skim milk, buttermilk, and whey, at their proper feeding value, and the calves yearly dropped, the annual aggregate value of the products of our dairy cows exceeds $500,000,000. This is regarded as a conservative estimate, and does not include the manure product, which has a very large but quite uncertain value.

If the value, per head, estimated for cows in this country, viz, $22 to $25, is accepted, these animals produce nearly 50 per cent more than their own value, annually. But there is an old farm rule, which has reasonable basis, that a cow is worth whatever she will produce in a year, including her calf. At this rate the average value of the dairy cow in the United States must be about $30.

The foregoing estimates are based upon an average yield of 350 gallons, or about 3,000 pounds of milk, yearly by each cow. This is rather more than shown by the census tables, but those exclude the large number of town cows, which would materially raise the average milk product. This rate of yield provides for butter and cheese product estimated and for consumption, besides the skim milk and buttermilk residue from the butter cows, about 25½ gallons of whole milk per annum per capita of our population. Two hundred and twenty pounds of milk for 365 days (rather more than one-half pint a day) is by no means an excessive allowance, but many people do not, in fact, approach that rate of consumption.

NEEDED IMPROVEMENT IN DAIRY CATTLE.

Assuming that the different products of the average dairy cow in America do not exceed much, if at all, the foregoing estimates, it is evident that the average cow of the country is far below a standard which is desirable and entirely practicable. The tables show that there has been a gradual improvement in the average cow product, especially during the last two or three decades. But the progress is by far too slow.

A very good annual average yield of milk is 5,000 pounds, instead of 3,000, and 200 to 225 pounds of butter per cow, instead of 125 pounds. Many herds kept in a plain, practical farm fashion attain still better results. There are manifestly many cows in the country, probably some millions, that do not produce the value of their annual cost, however cheap and wastefully poor their keeping may be. It is apparent that if but two cows were kept, of the suggested standard of production, in place of every three of the existing average quality, the aggregate products of the dairy industry of the country would be increased more than 10 per cent, while the aggregate cost to their owners ought to be less, and probably would be.

Every possible influence should be exerted to induce dairy farmers to weed out their herds and keep fewer cows and better ones. At least, the average quality of cows kept for dairy purposes should be brought up to a respectable and profitable standard. For the present the cow owner may reasonably require something over 2 gallons of milk per day for four months, then 2 gallons a day for the next four, and at least two months more in milk during the year, with constantly decreasing yield. This provides for an annual average yield of 5,000 pounds of milk, or about 575 gallons, which is a fair ideal standard for the dairy cow in the United States.

DISCUSSION OF THE AGRICULTURAL STATISTICS OF THE ELEVENTH UNITED STATES CENSUS.

By JOHN HYDE, *Expert Special Agent in Charge of Agriculture.*

[Extracts published by permission.]

NEAT CATTLE.

On June 1, 1890, the 4,564,641 farms in the United States contained 1,117,494 working oxen, 16,511,950 milch cows, and 33,734,128 other cattle—a total of 51,363,572.

On June 1, 1880, the 4,008,907 farms contained 993,341 working oxen, 12,443,120 milch cows, and 22,488,550 other cattle—a total of 35,925,011.

There is, therefore, an increase of 124,153, or 12.44 per cent, in the number of working oxen; of 4,068,830, or 32.70 per cent, in the number of milch cows, and of 11,245,578, or 50.01 per cent, in the number of other cattle, the increase in the total number of neat cattle on farms being 15,438,561, or 42.97 per cent.

On June 1, 1890, there were also 5,851,640 neat cattle on ranges (not including 433,580 in Indian Territory), of which 1,959,888 were cows and calves. On June 1, 1880, there was an estimated total of 3,750,022 neat cattle on ranges.

There is thus an apparent increase of 2,535,198, or 67.60 per cent, in the total number of neat cattle on ranges, and of 17,973,759, or 45.30 per cent, in the total number of neat cattle in the United States.

The State having the largest number of neat cattle on farms to every square mile of land surface is Iowa, where the average is 88.25, Illinois standing second, with an average of 54.70; Vermont, Connecticut, New York, Ohio, Indiana, and Missouri have between 40 and 50 neat cattle on farms for every square mile of land surface; Massachusetts, Rhode Island, Pennsylvania, Wisconsin, Kansas, and Oklahoma, between 30 and 40; New Hampshire, New Jersey, Delaware, Maryland, West Virginia, Nebraska, Kentucky, Tennessee, and Texas, between 20 and 30; Maine, the District of Columbia, Virginia, North Carolina, Georgia, Michigan, Minnesota, Alabama, Mississippi, Louisiana, and Arkansas, between 10 and 20; and South Carolina, Florida, North Dakota, South Dakota, Montana, Wyoming, Colorado, New Mexico, Arizona, Utah, Nevada, Idaho, Washington, Oregon, and California, under 10.

East of the Mississippi River it is only in the States of Vermont and Florida that there are 1,000 or more neat cattle on farms for every 1,000 of the population. West of the Mississippi River, however, the proportions are almost entirely reversed, there being few States or Territories west of that dividing line the number of whose neat cattle on farms is not largely in excess of population. In Wyoming there are 11 neat cattle on farms to each inhabitant, while the addition of those on the ranges in that State would increase the ratio to more than 15 to 1.

STATISTICS OF QUALITY.

The statistics of quality having been collected in 1890 for the first time, no comparison can be made with previous censuses, and the interest that attaches to this portion of the report is confined to the amount and distribution of the improved stock of the country in 1890 and to comparisons between States or groups of States. Taking the country as a whole, 0.99 per cent of neat cattle on farms in 1890 were pure-bred, 16.08 per cent were grades, one-half blood or higher, and 82.93 per cent were common or native, including grades of less than one-half blood. The highest percentage of pure-bred cattle, 1.77, is found in the North Atlantic Division, which has also 16.41 per cent of grades, making 18.18 per cent of its 5,461,724 neat cattle one-half blood or over. The North Central Division has a smaller percentage (1.21) of pure-bred, but its percentage of grades is 22.21, its total percentage of more than half-blood being thus 23.42. It is certainly a significant fact that of the large total of 24,572,400 neat cattle on farms in this division nearly one-fourth are of this high standard of quality. The South Atlantic Division has 0.73 per cent of pure-bred and 7.41 per cent of grades, and the South Central Division 0.46 per cent of pure-bred and 6.77 per cent of grades, while the Western Division, with only 0.52 per cent of pure-bred, appears, nevertheless, with 14.39 per cent of grades, owing to the exceedingly large proportion of grades reported from certain districts in Colorado, the figures for which could not be verified, nor was there, on the other hand, sufficient warrant for their modification. While the error, if any, will probably have affected the percentages of grades and common stock in the Western Division, the number of cattle involved was not sufficiently large for it to have had any appreciable effect upon the percentages for the United States as a whole.

Examining the statistics of quality by States and Territories, it is found that the highest percentage of pure-bred (5.97) was in the District of Columbia, and the highest percentage of grades, 29.90 (excluding Colorado, for the reasons stated), in Iowa, the highest percentage of pure-bred and grades combined (again excluding Colorado) being in Rhode Island, where 31.47 per cent of neat cattle on farms were half-blood or upward. There is, however, very little difference between Rhode Island and Iowa in this regard, the percentage in the latter State being 31.13. Among the North Atlantic States, Connecticut, Rhode Island, Massachusetts, and New Jersey have all over 3 per cent of pure-bred, and all of these, with the exception of New Jersey, have a very high percentage of grades. Maine and Vermont have a high percentage of grades, with a percentage of pure-bred differing but little from the average of the division as a whole. New York and New

Jersey have each only 1.50 per cent of pure-bred, while they have 15.39 and 11.68 per cent of grades, respectively. In the South Atlantic Group the percentage of pure-bred ranges from 5.97 in the District of Columbia and 2.33 in Maryland to 0.45 in Georgia and 0.25 in Florida; the percentage of grades ranging from 23.58 in the District of Columbia and 18.62 in Delaware to 3.22 in Georgia and 1.24 in Florida. The last-mentioned State appears to have the smallest number of improved stock in proportion to the total number of its neat cattle on farms of any State or Territory in the entire country. The percentage in the Carolinas and Georgia is also exceedingly low. Among the North Central States, Ohio has the highest percentage of pure-bred, but is exceeded both in percentage of grades and in that of pure-bred and grades combined by Iowa. Considering the systematic efforts that have been made to improve the quality of the neat cattle of Minnesota during recent years, it is somewhat surprising that that State should have a smaller total percentage of pure-bred and grades of one-half blood or upward than any other State in the division to which it belongs. The difference, however, between Minnesota, South Dakota, North Dakota, and Wisconsin is very small. There is a wide difference between the percentages in the various States composing the South Central Division—Kentucky having 1.52 per cent of pure-bred and 14.77 per cent of grades, while Louisiana has only 1.98 per cent of pure-bred and grades combined, the percentages in Arkansas, Alabama, and Mississippi being almost equally low. With the exception of Colorado, the States and Territories of the Western Division deviate less from the general average of the entire division than do the States of any other group. Marked differences, however, there certainly are, Utah having 1.25 per cent of pure-bred, as compared with 0.10 per cent in New Mexico and 0.08 per cent in Arizona, and California having 16.93 per cent of grades, as compared with 4.66 per cent in Idaho.

MILCH COWS ON FARMS.

The increase in the number of milch cows on farms between 1880 and 1890 is the largest ever reported, and in 1890 the number to every 100 of the population (26.4) was greater than at any census since 1860. At the censuses of 1850, 1860, 1870, and 1880 the number of milch cows reported as on farms was 6,385,094, 8,585,735, 8,935,332, and 12,443,120, respectively, the number per 100 of the population ranging from 23.2 in 1870 to 27.5 in 1850. This is a remarkably narrow range of fluctuation for five decennial censuses. Under normal conditions, however, the increase in the number of milch cows may be expected to keep pace with the increase of population, and it is interesting to note that out of 49 States and Territories, including the District of Columbia, 43 show an increase and only 6 a decrease between 1880 and 1890, the total increase in the 43 being 4,146,357 and the total decrease in the 6 only 77,527.

In the North Atlantic Division, a division which shows a decrease in the number and area of its farms and in many important branches of agriculture, every State had a larger number of milch cows in 1890 than in 1880. In Pennsylvania the increase was 73,098, in New Jersey 9,498, in New York 2,375, and in the six New England States 75,345, Massachusetts taking the lead with an increase of 21,611. The increase in this division, however, has not kept pace with the growth of population, the increase in the number of milch cows being only 5.02 per cent, while that of population was 19.95 per cent. While New York had a larger number of milch cows than any three other States in the division, not excluding even Pennsylvania, the ratio of milch cows to population was much the highest in Vermont, there being 696 to every 1,000 of the population in that State. In Franklin County, Vt., there were as many as 1,077 milch cows to every 1,000 of the population.

In the South Atlantic Division the largest increase is in Florida, which has 269 milch cows in 1890 for every 100 in 1880. West Virginia, Virginia, Maryland, and Delaware also show an increase. On the other hand, South Carolina and Georgia show a considerable decrease, especially the former; North Carolina and the District of Columbia also reporting a smaller number than in 1880. The decrease in South Carolina and Georgia, and to a less degree that in North Carolina, are especially noteworthy, not merely because the decline is considerable, but because these States form the only important exceptions to that increase in the number of milch cows which is reported from almost every part of the country. That the decrease in these States was more or less general is evident from the fact that in Georgia 77 counties show a decrease as compared with 60 showing an increase; in North Carolina 55 show a decrease as against 40 showing an increase, while in South Carolina 26 show a decrease and only 6 an increase. Taking the division as a whole, there is an increase of 88,705.

The North Central Division witnessed during the decade ending with 1890 an exceedingly large increase in the number of its milch cows and, as will be shown hereafter, a remarkable development of its dairy industry. The total number of milch cows reported as on farms in the 12 States comprised in this division is 8,240,999—49.91 per cent of the total number in the United States, and an increase of 2,838,918 upon the number reported from these 12 States in 1880. In Iowa, the division contains a State that has increased its number of milch cows by 644,231, and that has at length wrested from New York that primacy of position with respect to the number of milch cows and the total production of butter on farms and in factories which the latter State had so long maintained. In Iowa there are no fewer than 32 counties in which there are more than 1,000 milch cows for every 1,000 of the population, Delaware County standing at the head of these and all other counties in the United States with the high average of 1,630 to 1,000. In view of the greatly diminished area both of farms generally and of improved land in Illinois since 1880, the large increase in the number of milch cows in that State, 221,973, or 25.63 per cent, is especially noteworthy. The increase and percentage of increase in Wisconsin, Minnesota, Kansas, and Nebraska have, however, been even greater than in Illinois—Wisconsin showing an increase of 314,246, or 65.69 per cent; Kansas an increase of 323,453, or 77.32 per cent; Minnesota an increase of 318,363, or 115.54 per cent, and Nebraska an increase of 343,858, or 213.32 per cent. The increase in the Dakotas amounts to 257,957; these States reporting more than seven times as many milch cows in 1890 as were contained in the Territory of Dakota in 1880. There has also been a large increase in Michigan and Missouri, a smaller one, but one more commensurate with the growth of population, in Indiana, and an increase of 3.62 per cent, or less than one-fourth of that of population, in Ohio.

In the South Central Division, also, every State shows an increase, the additions to the numbers reported in 1880 ranging from 20,645 in Alabama and 20,769 in Louisiana to 397,263 in Texas. In Tennessee, Alabama, Louisiana, and Arkansas the increase has failed to keep pace with the growth of population, and that such has not been the case with the division as a whole is due to the very large increase (65.54 per cent) in Texas. A noteworthy feature of the statistics for this division is the comparative uniformity in the number of milch cows to every 1,000 of the population in three of the principal States, Kentucky having 196, Tennessee 195, and Alabama 193 milch cows for every 1,000 of their inhabitants. In Texas the average is as high as 449 per thousand, while in Louisiana it is only 149 per thousand.

In the Western Division there is a remarkable correspondence between the increase in population and the increase in the number of milch cows, the former amounting to 71.27 per cent and the latter to 70.76 per cent. With the exception of Arizona and Nevada, which show a decrease (the latter also showing a decrease in population), every State and Territory in this division contained a larger number of milch cows in 1890 than in 1880. In Utah the increase was more than two-fifths, and in Colorado and California more than one-half. The number in Oregon almost doubled, in Montana and Idaho it more than doubled, and in Wyoming it trebled, Washington, also, having a large increase amounting to 156.03 per cent. Only in California, however, was the increase in the decade as much as 100,000 or did the total number reported in 1890 reach 300,000 or even one-half of that number, and the total number of milch cows on farms in the whole of this vast region, comprising considerably more than one-third of the total land surface of the United States, was less than one-half the number in Iowa. At the same time the ratio of milch cows to population was higher in this division than in either the North Atlantic or South Atlantic Division.

DAIRY PRODUCTS.

The total production of milk on farms in the United States in the year ending December 31, 1889 (not including farms of less than 3 acres, except where $500 worth of the produce of the farm had been actually sold during the year), was 5,209,125,567 gallons, equivalent to 315½ gallons for each milch cow reported on June 1, 1890, and to 83 gallons per head of population.

The total production of butter on farms (as above defined) in the year ending December 31, 1889, was 1,024,223,468 pounds, as compared with a total of 777,250,287 pounds in 1879, and the total production of cheese 18,726,818 pounds, as compared with a total of 27,272,489 pounds in 1879, an increase of 246,973,181 pounds, or 31.78 per cent, in the production of butter on farms, and a decrease of 8,545,671 pounds, or 3 per cent, in the production of cheese on farms.

MILK PRODUCTION.

There are few, if any, products of agriculture, using that term in its widest application, the average rate of production of which varies more widely among the different States and Territories than does that of milk. As a general but not invariable rule the average production per milch cow has a certain correspondence with the report as to quality, the District of Columbia, which has the highest percentage of pure-bred cattle in the United States, having the highest average milk production, 533 gallons for each milch cow, while New Mexico, with the lowest percentage of pure-bred cattle, has the lowest average production of milk, only 38.75 gallons per milch cow. The proximity of a market for milk or dairy products is, however, a factor not entirely to be lost sight of in this connection.

Taking the country by grand divisions, the North Atlantic Division, with the highest percentage of pure-bred cattle, has the highest average milk production, 428.44 gallons per milch cow. The variation in the averages in this group of States is not great, the highest average production being 479.94 gallons in Massachusetts and 460.98 gallons in New York, and the lowest 368.58 gallons in Maine and 389.62 gallons in New Hampshire. The next highest divisional average is that of the North Central Division, which stands second also in its percentage of pure-bred cattle. Here the general average is 329.99 gallons, Michigan and Ohio having the highest average, 451.23 gallons and 411.31 gallons, respectively, and Missouri and Kansas the lowest, 227.87 gallons and 271.79 gallons, respectively. In the South Atlantic Division the general average is 242.23 gallons, the District of Columbia and State of Delaware having the highest averages, 533 gallons and 328.46 gallons, respectively, and the States of Georgia and Florida the lowest, 181.55 gallons and 44.60 gallons, respectively. In the South Central Division the general average is 183.66 gallons, the highest being 325.08

gallons in Kentucky and 311.77 gallons in Tennessee, and the lowest 77.03 gallons in Louisiana and 92.16 gallons in Oklahoma. The statistics of the Western Division present several noteworthy features. Among them is a remarkable variation in the average production per milch cow, as between one State or Territory and another, such production ranging from 38.75 gallons in New Mexico to 350.54 gallons in California. Another is the comparatively high average production in some of the new and sparsely populated States, Wyoming and Montana having averages of 262.29 gallons and 250.10 gallons, respectively. The production per capita of population in these States is, however, much below the general average for the United States, and, as is evident from the report, more than one-half of the total milk production of Montana and not far from one-half of that of Wyoming were used in the production of butter and cheese on farms.

The total production of milk in the United States in 1889, compared with the total population in June, 1890, gives an average of about 83 gallons for each inhabitant. The ratio was the highest in the North Central Division, where it was 122 gallons per unit of the population, the States comprised in this division producing, as will be shown hereafter, more than one-half the butter and one-third of the cheese made in the United States, both on farms and in factories. The ratio of milk production to population in the North Atlantic Division was nearly 83 gallons for each inhabitant, in the Western Division it was not quite 67 gallons, while in the South Atlantic and South Central divisions it was 37 gallons and 47 gallons, respectively.

The only States in which the production of milk amounted to 100 gallons or upward per capita of population were New Hampshire, Vermont, and New York in the North Atlantic Division, and Michigan, Wisconsin, Minnesota, North Dakota, South Dakota, Iowa, Nebraska, and Kansas in the North Central Division. Only in Vermont and Iowa was there a production of 200 gallons or upward for each inhabitant. The average in the District of Columbia is less than 2 gallons per capita, the city of Washington deriving its milk supply, mainly, from the States of Maryland and Virginia. In New Mexico the production was less than 5 gallons per capita of population; in Louisiana and Arizona it was under 12 gallons, and in Florida under 13 gallons for each inhabitant.

BUTTER PRODUCTION ON FARMS.

The most noteworthy fact in connection with the production of butter on farms is that, notwithstanding the great extension of the creamery system and the decline in the amount of butter annually exported, such production has increased even more rapidly than population. To go back to the census of 1850, it is found that the total production of butter on farms in 1849 was 313,345,306 pounds, or 13.51

pounds per capita of population. In 1860 the amount reported was 459,681,372 pounds, or 14.62 pounds per capita. In 1870 the amount reported was 514,092,683 pounds, which gave an average of only 13.33 pounds for each inhabitant. Up to this time there had been no creamery butter reported, but in 1880 the production of farm butter averaged 15.50 pounds for each inhabitant, and that of creamery butter 0.58 pound for each inhabitant, the total average being thus 16.08 pounds. At the Eleventh Census, however, the production of butter on farms alone averaged 16.33 pounds per capita of the population, and such had been the increase in the production of butter in creameries that the total production of butter averaged no less than 19.24 pounds per unit of the population.

The complete statistics of the production of butter in creameries, or factories, as such establishments are designated for census purposes, will be found in the report on manufactures, and they are referred to in this connection merely for the purpose of emphasizing the remarkable increase in the production on farms.

The increase in the production of farm butter, as distinguished from that made in creameries, has been very general, 39 States and Territories, considering the two Dakotas as a unit for convenience of comparison with the statistics of 1879, reporting an increase, and only 8, including the District of Columbia, a decrease. It is a significant fact that the whole of the States from which a smaller production of farm butter is reported than at the Tenth Census belong to the North Atlantic Division. Every other portion of the country shows an increase in its production of butter on farms, and, as a rule, the States that have witnessed the greatest extensions of the creamery system, such as Wisconsin, Minnesota, Iowa, and Nebraska, show also the greatest increase in the production of butter on farms. The North Central Division, which appears from the report on manufactures to have produced 72.03 per cent of the total production of creamery butter, produced 50.83 per cent of the total amount of farm butter, and its production, both on farms and in creameries, per capita of the population, is much higher than that of any other of the five grand divisions of States. That concentration of production, which has always been a distinguishing feature of American agriculture, has a remarkable exemplification in the case of butter, an article, the production of which, to a greater or less extent, is almost as general as is its consumption, but more than one-half of whose total production in the United States has, nevertheless, to be credited to 7 States, and almost one-fourth more to 7 others. It should, however, be remembered that the States of principal production are, with a few exceptions, those in which the creamery industry has attained its largest development.

In the production of butter on farms per capita of population, Vermont is far in the lead, its average being 70.14 pounds. On the other hand, the production on farms and in factories combined was under 10 pounds in Washington, under 9 pounds in Montana, Colorado, and Utah, under 8 pounds in Wyoming, under 7 pounds in New Jersey, under 5 pounds in Massachusetts, and under 4 pounds in Rhode Island, for each inhabitant, while in some of the States in which there are no creameries the average production per capita is still smaller, Florida reporting less than 3 pounds and Louisiana and Arizona less than 2 pounds, and New Mexico less than 1 pound for each inhabitant. Of the States in which the production of butter on farms and in creameries is of the greatest importance, relatively to population, Vermont has a production of over 80 pounds per capita, Iowa of over 60 pounds, South Dakota of over 40 pounds, and Wisconsin, Minnesota, North Dakota, Nebraska, and Kansas of over 30 pounds.

Attention has already been called to the large increase in the number of milch cows. The increase in the production of butter per capita of population is, however, due, not alone to the increase in the number of cows, but in no inconsiderable degree to the general stimulus that not only the creamery system, but also the dairy industry, as distinguished from the creamery, is known to have received during the decade ending with 1890, and the result of which is seen in the fact that, while the average production of butter on farms and in factories at the Tenth Census was 64.83 pounds for each milch cow, the average production at the Eleventh Census was 72.98 pounds, an increase of 12.57 per cent. That this is not due directly, if at all, to the extension of the creamery system is shown by the fact that nearly all the States that have witnessed the greatest extension of that system during the decade ending with 1890 show a smaller average production of butter per milch cow than at the Tenth Census, and that many of the leading Southern States that contain no creameries whatever show a remarkable increase in the average production of butter per milch cow, such increase ranging from 50.36 per cent in Mississippi and 52.56 per cent in Arkansas to the increase in Louisiana, where the average production has almost doubled, and in South Carolina and Georgia, where it has more than doubled. In this connection, however, it is important to note that from a considerable number of counties in the South, especially in Georgia, a butter production is reported far in excess of the maximum butter-producing capabilities of the entire milk production of such counties. While this apparent error on the part of enumerators can not but affect, to a greater or less extent, both the total production, either of milk or of butter and the averages for such counties and even for the States in which they are contained, it is not sufficiently general to alter the fact that there has been an increase in the production of butter on the farms and plantations of the Southern States far out of proportion to the increase in the number of milch cows.

PRODUCTION OF CHEESE ON FARMS.

If a reference to the production of butter in creameries is necessary to a proper consideration of the statistics of the production of butter on farms, much more is a reference to the production of cheese in factories necessary to a proper understanding of the statistics of the production of cheese on farms, for while nearly 6 times as much butter is made on farms as in creameries, nearly 13 times as much cheese is made in factories as on farms, and while the production of cheese on farms shows a decrease of nearly one-third, such decrease is more than doubly offset by the increase in the production of cheese in factories. It is exceedingly interesting to observe how the production of cheese on farms has gradually given place to the factory system and how the remarkable change that has been brought about is shown in the statistics of successive censuses. In 1850 there was a reported production of cheese on farms amounting to 105,535,893 pounds; in 1860 the amount reported was 103,663,927 pounds; in 1870 it was 53,492,153 pounds; in 1880, 27,272,489 pounds, and in 1890, 18,726,818 pounds. The reported production in factories began with $67,210 worth in 1850, which was followed by $23,500 worth in 1860, the only decrease ever reported. In 1870 the factory production amounted to 109,435,229 pounds, in 1880 to 215,885,361 pounds, and in 1890 to 238,013,565 pounds.

The largest decrease and percentage of decrease in the production of cheese on farms during the decade ending with 1889 was in the States composing the North Atlantic Division, every one of which has a diminished production, whether the industry is one of considerable importance, as in New York, or of but minor importance, as in Rhode Island and New Jersey. This is not due to the extension of the factory system, as the production of cheese in factories also shows a decrease. In the North Central Division, likewise, the production of cheese on farms was considerably less in 1889 than in 1879, Minnesota, Missouri, the Dakotas, Nebraska, and Kansas forming the only exceptions to the rule. While, however, there has been a remarkable development of the factory system in this division, such extension has been by no means general, Ohio, Indiana, and Illinois showing a diminished production, both in factories and on farms. While in 1879 Ohio and Wisconsin each reported over 2,000,000 pounds, and Illinois and Iowa each over 1,000,000 pounds of cheese made on farms, an amount in excess of 1,000,000 pounds is reported for 1889 only by Ohio and Iowa. As in the case of the creamery system of butter-making, this division, the North Central, is the one that has witnessed during the decade the greatest extension of the cheese-factory system, Wisconsin alone having increased its production of cheese in factories over that reported at the Tenth Census by upward of 36,000,000 pounds (see report on manufactures).

But little cheese is made in the South, the total production on farms of the South Atlantic and South Central divisions being only 589,658 pounds in 1889 and 567,841 pounds in 1879, while the total production in factories fell from 349,147 pounds in 1879–80 to 78,800 pounds in 1889–90. Of the production on farms, Virginia and Texas each contributed over 100,000 pounds. On the other hand, the combined farm production of South Carolina, Florida, Alabama, Mississippi, and Louisiana was only 19,175 pounds, and none of these last-mentioned States reports any production in factories.

In most of the States and Territories of the far West cheese-making on farms gives evidence of having received a decided impetus during the decade, New Mexico producing nearly twice, Nevada nearly 3 times, Wyoming over 5 times, Colorado over 8 times, and Idaho over 10 times as much cheese on farms in 1889 as in 1879. Utah, Oregon, and California also show a large increase, the increase in Utah, however, being more than offset by the diminished production of its factories. Montana and Arizona not only report a smaller production on farms than at the Tenth Census, but are no longer to be credited with any production whatever in factories.

The total production of cheese on farms and in factories per capita of population was not only less in 1889–90 than in 1879–80, but even less than in 1849–50. In Wisconsin this total production in 1889–90 averaged 33.7 pounds for each inhabitant, in New York 20.7 pounds, and in Vermont 18.6 pounds. For the entire country, however, the average per capita of population was only 4.10 pounds, of which less than 5 ounces represented the production on farms. Only in California, Idaho, Vermont, Nevada, and Maine did the production on farms average 1 pound or upward for each inhabitant.

In connection with the relative decline of cheese-making in the United States, of which there is further evidence in the fact that the total production per milch cow in 1889–90 was 4 pounds less than in 1879–80, reference may be made to the fact that the total exports of cheese in the fiscal year ending June 30, 1890, were only 95,376,053 pounds as compared with a total of 127,553,907 pounds in the fiscal year ending June 30, 1880. Whether the shrinkage of exports, which was gradual, was due to a similar gradual diminution of the amount available for export after the requirements of the country had been supplied—the consumption per capita increasing while the production per capita was decreasing—or whether the relatively slow growth of the industry was due, wholly or in part, to a gradually decreasing foreign demand, it does not come within the scope of the census to determine.

GENERAL AGRICULTURAL STATISTICS.

TABLE I.—*Farm and dairy statistics of the United States.*

	From the United States Census of—				
	1890.	1880.	1870.	1860.	1850.*a*
Population	62, 622, 250	50, 155, 783	38, 558, 371	31, 443, 322	23, 191, 876
Occupations:					
Total persons reported	22, 735, 661	17, 392, 000	....	....	....
Number in agriculture	8, 466, 251	7, 670, 493	5, 922, 471	3, 221, 574	2, 400, 583
Farms:					
Total number	4, 564, 641	4, 008, 907	2, 659, 985	2, 044, 077	1, 449, 075
Area, total ....acres	623, 218, 619	536, 081, 835	407, 735, 041	407, 212, 538	293, 560, 614
Acres unimproved, percentage	42. 6	46. 9	53. 7	59. 9	61. 5
Average size..........acres	137	134	153	199	203
Number cultivated by owner	3, 269, 728	2, 984, 306	....	....	....
Number rented for money	454, 659	322, 357	....	....	....
Value land, buildings, etc., dollars	13, 279, 252, 649	10, 197, 096, 776	9, 262, 803, 861	6, 645, 045, 007	3, 271, 575, 426
Value implements and machinery............dollars	494, 247, 467	406, 520, 055	336, 878, 429	246, 118, 141	151, 587, 638
Value live stock, all kinds, dollars	2, 208, 767, 573	1, 500, 384, 707	1, 525, 276, 457	1, 089, 329, 915	544, 180, 516
Value farm products, annual (*b*)............dollars	2, 460, 107, 454	2, 212, 540, 927	2, 447, 538, 658	....	....
Cattle:					
Milch cows.........number	16, 511, 950	12, 443, 120	8, 935, 332	8, 585, 735	6, 385, 094
All others on farms....do	34, 851, 622	23, 482, 391	14, 885, 276	17, 034, 244	11, 393, 813
Cows to every 1,000 of population	264	248	232	273	275
Milk, total produced on farms, gallons	5, 209, 125, 567	530, 129, 755	235, 500, 599	(*c*)	(*c*)
Butter made on farms (*d*).pounds	1, 024, 223, 468	777, 250, 287	514, 092, 683	459, 681, 372	313, 345, 306
Cheese made on farms (*d*) ...do	18, 726, 818	27, 272, 489	53, 492, 153	103, 663, 927	105, 535, 893
Creameries, cheese factories, etc.:					
Number (*e*)	4, 712	3,932	1, 313	5	8
Butter made in same (*df*), pounds	181, 284, 916	29, 421, 784	....	....	....
Cheese made in same (*df*), pounds	238, 035, 065	215, 885, 361	109, 435, 229	....	....
Condensed milk ....pounds	37, 926, 821	13, 033, 267	....	....	....
Capital employed....dollars	16, 624, 163	9, 604, 803	3, 690, 075	13, 400	11, 950
Employees .... number	14, 921	7, 903	4, 607	13	55
Wages paid, annual .dollars	5, 390, 705	1, 546, 495	706, 566	3, 060	11, 676
Cost of materials ......do	51, 364, 574	18, 363, 579	14, 089, 284	10, 791	54, 419
Value of products .....do	62, 686, 043	25, 815, 963	16, 771, 665	23, 500	67, 210
Total dairy products of United States (*g*), value ....dollars	411, 976, 522	391, 131, 618	360, 828, 000	240, 400, 580	166, 193, 144

---

a The Sixth United States Census (1840) gives number of milch cows, 4,837,043; value, $72,555,000; value of dairy products for year, $120,926,075.

b The value of farm products for 1869 (census of 1870) included "betterments and additions to stock," so that in products only there was an actual increase in 1880, as compared with 1870. The total value of 1890, compared with 1880, showed only slight increase, although increase in the products themselves was very great; rapid decrease in market prices accounts for this difference.

c No returns of milk product were made for 1850 and 1860. The great variation in the figures given results from these facts: In 1870, only "milk sold from farms" was reported, thus omitting all consumed on farms and there made into butter and cheese; in 1880, "milk sold or sent to butter and cheese factories" was included, again excluding home consumption; in 1890, the returns endeavored to show the total quantity of milk produced on farms.

d To butter and cheese made on farms must be added that made at creameries and cheese factories to get the total product of the country (see Table III). The progressive increase in the production of butter and cheese in the United States, and the ratio of farm and factory product, is graphically shown by Diagram C.

e The establishments reported for 1850, 1860, and 1870 were all cheese factories. The figures for 1850 are approximately correct, but those for 1860 are not; more cheese factories are known to have been in active operation in that year in the State of New York alone.

f The butter and cheese made in creameries and factories in 1889 (census of 1890) does not include the products of urban establishments (see Table IV).

g The total values of dairy products do not include the milk of "town cows" or cows not on farms, and the amounts given are thus much below the whole truth.

Diagram A.—*Relative values of principal farm products of the United States in 1859, 1879, and 1889.*

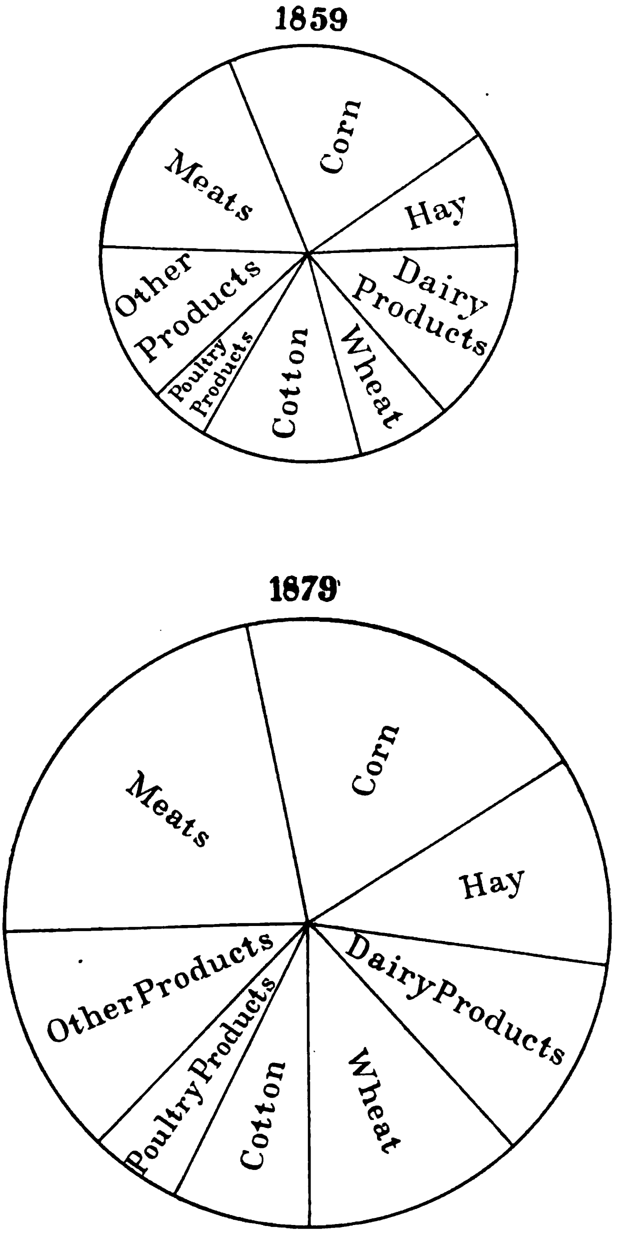


DIAGRAM A.—*Relative value of principal farm products of the United States in 1859, 1879, and 1889.*

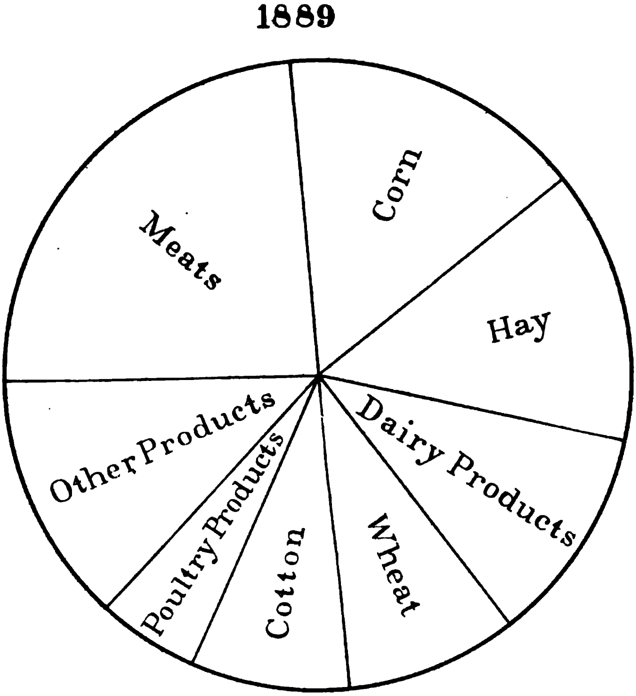


Diagram A shows, graphically, the relative values of important farm products for the years 1859, 1879, and 1889. Some important products are omitted in this comparison because their values can not be obtained. Dairy products increased only a little in the last decade, but their increase in value was practically in the same ratio as that of all the other stated products combined.

Value of principal farm products of the United States.

Products.	1859.		1879.		1889.	
	Per cent.	Total value.	Per cent.	Total value.	Per cent.	Total value.
Meats	17.9	$300,000,000	22.1	$800,000,000	23.9	$900,000,000
Corn	21.6	360,680,878	19.2	694,818,304	15.9	597,918,829
Hay	9.1	152,671,168	11.3	409,505,783	14	526,632,062
Dairy products	14.4	240,400,580	10.8	391,131,618	11	411,976,522
Wheat	7.5	124,635,545	12.0	436,968,463	9.1	342,491,707
Cotton	12.6	211,516,625	7.5	271,636,121	8.2	307,008,114
Poultry	4.5	75,000,000	5	180,000,000	5.3	200,000,000
Other products (*a*)	12.4	206,639,527	12.1	440,438,353	12.6	472,492,249
Grand total	100	1,671,544,323	100	3,624,498,642	100	3,758,519,483

[a] "Other products" include barley, buckwheat, flax fiber, flaxseed, hemp, hops, Irish potatoes, leaf tobacco, maple sirup, maple sugar, oats, rice, rye, sorghum molasses, sweet potatoes, and wool.

TABLE II.—*Dairy statistics by States.*

[From the Eleventh United States Census, 1890.]

States and Territories.	Milch cows.	Milk all produced on farms.	Butter made on farms.	Butter made at creameries.	Cheese made on farms.	Cheese made at factories.
	Number.	*Gallons.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
The United States...	16,511.950	5,209,125,567	1,024,223,468	181,284,916	18,726,818	238,035,065
North Atlantic Division...	3,351,061	1,435,739,255	246,788,544	48,245,172	6,693,671	132,545,023
Maine..................	157,278	57,969,791	15,593,315	1,406,041	696,052	755,761
New Hampshire.......	109,423	42,633,268	7,942,840	1,919,590	341,235	103,386
Vermont...............	231,419	90,712,230	23,314,063	5,085,377	609.586	5,582,327
Massachusetts.........	172,046	82,571,924	8,358,703	2,051,597	122,900	262,633
Rhode Island..........	23,943	10,610,547	965,456	233,783	24,631	300.000
Connecticut	127,892	54,413,822	7,196,095	3,173,164	112,566	195,955
New York..............	1,440,230	663,917,240	98,241,813	14,485,702	4,324,028	119,762,496
New Jersey............	101,576	64,003,953	8,367,218	499,531	23,613	563.628
Pennsylvania..........	927.254	368,906,480	76,809.041	19,390,387	439,060	5,018,837
South Atlantic Division...	1,369,466	331,728,677	78,270,911	2,143,928	271,291	144,000
Delaware..............	32,574	10,699.362	2,026,498	466,761	359	....
Maryland..............	142.198	46,601,218	9,999,602	847,277	9,573	14,000
District of Columbia...	863	459,978	13.769	....	....	....
Virginia...............	273,634	78,143,459	17,949,966	811,890	109,187	109,000
West Virginia.........	188,492	59,449,066	14,063,627	18,000	74,372	21,000
North Carolina	223.416	55,250,665	13,129,374	....	60,760	....
South Carolina.........	107,184	23,833,631	5,737,557	....	2,476	....
Georgia................	287,717	52,234,508	14,483,323	....	12.833	....
Florida	113,388	5,056,790	867,195	....	1,731	....
North Central Division....	8,240,999	2,719,414,765	520,625,636	129,925,952	6,669,421	103,556,440
Ohio....................	794,833	326,925,396	74,990,307	6,532,485	1,068,083	21,185,971
Indiana................	579.287	200,510,797	48,477,766	1,677,088	360,948	830,552
Illinois	1,087,886	367,269,464	57,121,486	25,553.422	343,456	10,005.477
Michigan	497,611	224,537,488	50,197,481	2,145,731	328,682	5,041,778
Wisconsin.............	792,620	303,701,134	46,295,623	14,059,876	906,266	53,708,595
Minnesota	593,908	182,968,973	34,766,409	13,911,095	676,642	3,615,528
Iowa....................	1,498,418	486,961,411	72,893.079	53,143,140	1,038,358	4,705,576
Missouri...............	851,076	193,931,103	43,108,521	1,529,647	288,620	1,384,397
North Dakota..........	88,289	26,566,112	5,712,566	446,296	131,374	49,000
South Dakota..........	210,240	59,666.525	13,127,244	532,513	303.951	250,812
Nebraska..............	505,045	144,768,263	27,818,078	6,076,783	463,831	804,618
Kansas	741,786	201,608,099	46,117,076	4,317,876	759,210	1,974,136
South Central Division....	2,829,657	519,693,663	135,192,272	110,679	318,367	31,300
Kentucky	364,516	118,497,289	29,038,406	....	64,822	....
Tennessee	345,311	107,657,116	28,314,387	65,990	69.919	31,300
Alabama...............	292.088	55,508,687	14,548,435	....	6,131	....
Mississippi	310,159	50,803,371	12,988,637	....	4,898	....
Louisiana..............	167,223	12,881,927	2,089,774	....	3.939	....
Texas	1,003,439	118.475,320	32,100,560	44,689	145,730	....
Oklahoma..............	16,756	1,544,280	387,920	....	1,600	....
Arkansas...............	330,165	54,325,673	15,724,144	....	21,328	....
Western Division..........	720,767	202,549,207	43,346,105	820,185	4,774,068	1,745,802
Montana...............	24,143	6,038,096	1,062,185	....	11,512	....
Wyoming..............	11.684	3,064.588	428,269	....	15,196	....
Colorado..............	76,948	19,680,791	3,282.086	339,000	87,183	44,500
New Mexico...........	18,507	717,155	86,042	....	18,981	....
Arizona................	4,874	709,225	115,203	....	10,855	....
Utah....................	45,982	8,614,694	1,759,354	55,800	163,539	13,200
Nevada	9,273	2,532,052	489,657	....	51,207	....
Idaho...................	27,278	5,085,863	1,078,103	13,650	207,213	116,640
Washington	70,721	19,873,281	3,482,225	1,500	71,281	249,700
Oregon	114,156	25,042,276	4,786,277	138,468	265,576	230,540
California..............	317,201	111,191,186	26,776,704	271,767	3,871,575	1,091,222

DIAGRAM B.—*Total cheese and butter production of the United States in 1890, by States, arranged according to rank.*

[The number in the center of each subdivision denotes the percentage of the total product represented which was made in that State.]

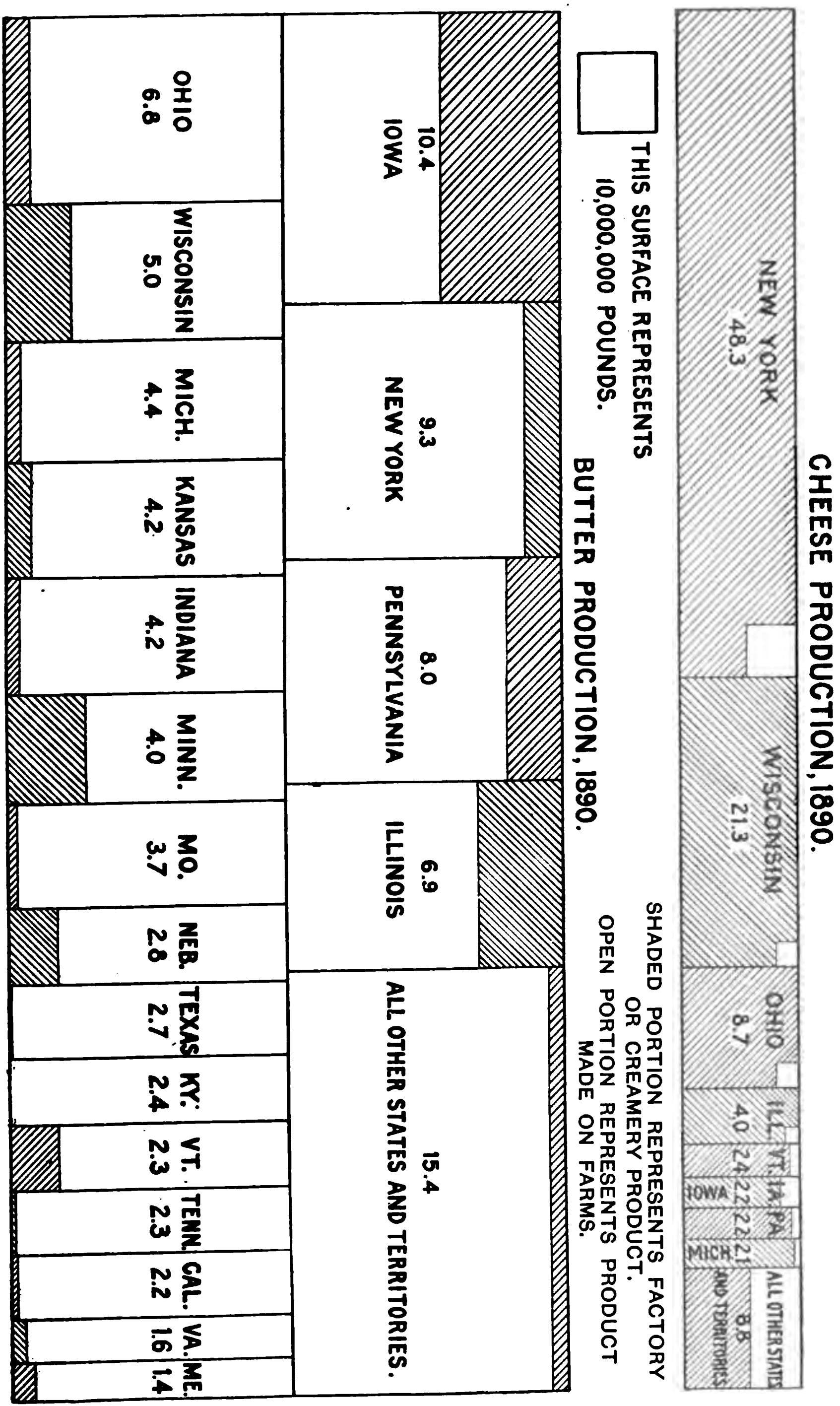


TABLE III.—*Progress of dairying in the United States.*

[United States Census statistics for half a century.]

States and Territories.	Year of census.	Milch cows.		Milk, product reported.	Butter, total made.	Cheese, total made.	Creameries and cheese factories.	Milk, average yield per cow.
		Total number.	Per 1,000 persons.					
				Gallons.	*Pounds.*	*Pounds.*	*Number*	*Gallons.*
United States...	1890	16,511,950	264	5,209,125,567	1,205,508,384	256,761,883	4,712	315.4
	1880	12,443,120	248	*530,129,755	806,672,071	243,157,850	3,932	232.5
	1870	8,935,332	232	†235,500,599	514,092,683	162,927,382	*a* 1,313	205.9
	1860	8,585,735	273	Not given.	459,681,372	103,663,927	*a* *b* 5	174.7
	1850	6,385,094	275	Not given.	313,345,306	105,535,893	*a* 8	166.5
North Atlantic Division...............	1890	3,351,061	193	1,435,739,255	295,033,716	139,238,694	1,971	428.4
	1880	3,190,745	220	*345,749,869	277,008,072	150,902,229	1,975	....
	1870	2,833,022	230	†186,605,146	225,910,518	35,144,853	*a* 913	....
	1860	2,615,929	......	....	223,950,757	72,860,013	....	....
	1850	2,188,503	......	....	173,055,728	79,731,981	....	....
Maine	1890	157,278	238	57,969,791	16,999,356	1,451,813	42	368.5
	1880	150,845	232	*3,720,783	14,109,966	1,945,095	41	314.2
	1870	139,259	222	†1,374,091	11,636,482	1,152,590	0	270.2
	1860	147,314	235	....	11,687,781	1,799,862	....	252.3
	1850	133,556	229	....	9,243,811	2,434,454	....	228.9
New Hampshire	1890	109,423	290	42,633,268	9,862,430	444,623	23	389.6
	1880	90,564	261	*5,739,128	7,346,340	807,076	2	313.8
	1870	90,583	285	†2,352,884	5,965,080	872,368	*a* 2	234.5
	1860	94,880	291	....	6,956,764	2,232,092	....	247.4
	1850	94,277	265	....	6,977,056	3,196,563	....	261.6
Vermont........	1890	231,410	697	90,712,230	28,399,440	6,191,913	124	393.9
	1880	217,033	654	*6,526,550	25,252,663	6,129,879	85	387.3
	1870	180,285	545	†3,835,840	17,844,396	7,814,879	*a* 28	349.5
	1860	174,667	554	....	15,900,359	8,215,030	....	328
	1850	146,128	465	....	12,137,980	8,720,834	....	318.8
Massachusetts..	1890	172,046	77	82,571,924	10,410,300	885,533	37	479.9
	1880	150,435	84	*29,662,953	9,799,804	2,201,393	22	396.2
	1870	114,771	79	†15,284,057	6,559,161	4,131,359	*a* 23	327.4
	1860	144,492	117	....	8,297,936	5,294,090	....	215
	1850	130,099	131	....	8,071,370	7,088,142	....	249.7
Rhode Island ...	1890	23,943	60	10,610,547	1,199,239	824,631	4	443.1
	1880	21,460	78	*3,831,706	1,007,103	67,171	0	323
	1870	18,806	87	†1,944,044	941,199	81,976	0	258.6
	1860	19,700	113	....	1,021,767	181,511	....	166.3
	1850	18,698	126	....	995,670	316,508	....	179.5
Connecticut	1890	127,892	171	54,413,822	10,369,259	308,521	50	425.4
	1880	116,319	187	*12,289,893	8,418,906	1,051,677	16	325.4
	1870	98,889	184	†6,253,259	6,716,007	2,262,894	*a* 7	290.9
	1860	98,877	215	....	7,620,912	3,898,411	....	277.2
	1850	85,461	230	....	6,498,119	5,363,277	....	301.3
New York	1890	1,440,230	240	663,917,240	112,727,515	124,086,524	1,337	460.9
	1880	1,437,855	283	*231,965,533	120,878,201	129,163,714	1,652	401.6
	1870	1,350,661	308	†135,775,919	107,147,526	100,776,012	*a* 818	358.2
	1860	1,123,634	290	....	103,097,280	48,548,289	....	325.7
	1850	931,324	301	....	79,766,094	49,741,413	....	319.8
New Jersey	1890	161,576	112	64,003,953	8,866,749	587,241	16	396.1
	1880	152,078	134	*15,472,783	9,872,237	569,736	11	289.9
	1870	133,331	147	†5,373,323	8,266,023	478,336	*a* 8	226.6
	1860	138,818	207	....	10,714,447	182,172	....	233.1
	1850	118,736	242	....	9,487,210	365,756	....	243.3
Pennsylvania...	1890	927,254	176	368,906,480	96,199,428	5,457,897	338	397.8
	1880	854,156	199	*36,540,540	80,322,852	8,966,737	146	322.8
	1870	706,437	201	†14,411,729	60,834,644	2,792,676	*a* 27	280.6
	1860	673,547	232	....	58,653,511	2,508,556	....	265.6
	1850	530,224	229	....	39,878,418	2,505,034	....	231.1
South Atlantic Division	1890	1,369,466	155	331,728,677	80,414,839	415,291	50	242.2
	1880	1,280,761	169	*9,446,511	48,703,330	640,065	31	....
	1870	1,001,094	171	†3,187,589	28,575,306	190,890	*a* 5	....
	1860	1,238,633	......	....	33,941,403	369,302	....	....
	1850	1,246,678	......	....	28,105,896	610,836	....	....
Delaware	1890	32,574	194	10,699,362	2,493,259	359	6	328.4
	1880	27,284	186	*1,132,434	1,902,075	1,712	8	247.9
	1870	24,082	192	†758,603	1,171,963	315	0	177.5
	1860	22,595	202	....	1,430,502	6,579	....	190.3
	1850	19,248	209	....	1,055,308	3,187	....	164.7
Maryland.......	1890	142,198	136	46,601,218	10,846,879	23,573	24	327.7
	1880	122,907	131	*4,722,944	7,715,196	79,416	14	221.3
	1870	94,794	121	†1,520,101	5,014,729	6,732	0	174.8
	1860	99,463	145	....	5,265,295	8,342	....	158.9
	1850	86,856	149	....	3,806,160	3,975	....	131.5

* "Milk sold or sent to butter and cheese factories, gallons," census, 1880.
† "Milk sold from farms, gallons," census, 1870.
a Cheese factories only. *b* See Note *e* of Table I.

TABLE III.—*Progress of dairying in the United States*—Continued.

[United States Census statistics for half a century.]

States and Territories.	Year of census.	Milch cows.		Milk, product reported.	Butter, total made.	Cheese, total made.	Creameries and cheese factories.	Milk, average yield per cow.
		Total number.	Per 1,000 persons.					
South Atlantic Division—Continued.				*Gallons.*	*Pounds.*	*Pounds.*	*Number*	*Gallons.*
Dist. Columbia..	1890	863	4	459, 978	13, 769	....	4	532. 9
	1880	1, 292	7	* 496, 789	88, 520	155, 460	1	433. 1
	1870	657	5	† 126, 077	4, 495	....	0	212. 4
	1860	639	9	....	18, 835	....	....	88. 4
	1850	813	16	....	14, 872	1, 500	....	57
Virginia........	1890	273, 634	165	78, 143, 459	18, 761, 856	218, 187	13	285. 5
	1880	243, 061	161	* 1, 224, 469	11, 500, 023	111, 535	4	147
	1870	188, 471	154	† 266, 812	6, 979, 269	84, 243	*a* 2	113
	1860	330, 713	207	....	13, 464, 722	280, 852	....	123. 1
	1850	317, 619	223	....	11, 089, 359	436, 292	....	106. 3
West Virginia ..	1890	188, 492	247	59, 449, 066	14, 081, 627	95, 372	3	315. 3
	1880	156, 956	254	* 750, 279	9, 309, 517	196, 987	7	183. 5
	1870	104, 434	236	† 144, 895	5, 044, 475	32, 429	0	146. 7
North Carolina .	1890	223, 416	138	55, 250, 665	13, 129, 374	60, 760	0	247. 2
	1880	232, 133	166	* 446, 798	7, 213, 507	57, 380	2	95. 4
	1870	196, 731	184	† 17, 145	4, 297, 834	123, 985	*a* 3	66. 1
	1860	228, 623	230	....	4, 735, 495	51, 119	....	62. 4
	1850	221, 799	255	....	4, 146, 290	95, 921	....	56. 6
South Carolina .	1890	107, 184	93	23, 833, 631	5, 737, 557	2, 476	0	222. 3
	1880	139, 881	140	* 257, 186	3, 196, 851	16, 018	0	70. 5
	1870	98, 693	140	† 241, 815	1, 461, 980	169	0	46. 9
	1860	163, 938	233	....	3, 177, 934	1, 543	....	58. 2
	1850	193, 244	289	....	2, 981, 850	4, 970	....	46. 3
Georgia	1890	287, 717	157	52, 234, 508	14, 483, 323	12, 833	0	181. 5
	1880	315, 073	204	* 374, 645	7, 424, 485	19, 151	0	72
	1870	231, 310	195	† 109, 139	4, 490, 572	4, 292	0	58. 9
	1860	299, 688	284	....	5, 439, 765	15, 587	....	54. 5
	1850	334, 223	369	....	4, 640, 559	46, 976	0	41. 8
Florida	1890	113, 388	290	5, 056, 790	867, 195	1, 731	0	44. 5
	1880	42, 174	157	* 40, 967	353, 156	2, 406	0	26. 2
	1870	61, 922	329	† 3, 002	100, 989	25	0	4. 9
	1860	92, 974	664	....	408, 855	5, 280	....	13. 3
	1850	72, 876	838	....	371, 498	18, 015	....	15. 6
North Central Division	1890	8, 240, 999	369	2, 719, 414, 765	650, 551, 588	110, 225, 861	2, 617	317. 8
	1880	5, 402, 081	311	* 155, 044, 519	383, 455, 099	86, 532, 570	1, 648	....
	1870	3, 294, 007	254	† 38, 853, 454	214, 400, 425	14, 178, 005	388	....
	1860	2, 556, 536	.....	....	153, 071, 558	28, 238, 411	....	....
	1850	1, 564, 219	.....	....	80, 563, 732	24, 547, 518	....	....
Ohio	1890	794, 833	216	326, 925, 396	81, 522, 792	22, 254, 054	361	411. 3
	1880	767, 043	240	* 46, 801, 537	69, 722, 506	32, 531, 683	452	328. 8
	1870	654, 390	246	† 22, 275, 344	50, 266, 372	24, 153, 876	195	279
	1860	676, 585	289	....	48, 543, 162	21, 618, 893	....	252. 5
	1850	544, 499	275	....	34, 449, 379	20, 819, 542	....	234. 4
Indiana.........	1890	579, 287	264	200, 510, 797	50, 154, 854	1, 191, 500	55	346. 1
	1880	494, 944	250	* 6, 723, 840	37, 712, 316	1, 676, 825	49	241
	1870	393, 736	234	† 936, 983	22, 915, 385	391, 487	17	177. 8
	1860	363, 553	269	....	18, 306, 651	605, 795	....	153
	1850	284, 554	288	....	12, 881, 535	624, 564	....	138. 4
Illinois	1890	1, 087, 886	284	367, 269, 464	82, 674, 908	10, 348, 933	266	337. 5
	1880	865, 913	281	* 45, 419, 719	60, 208, 972	21, 253, 194	285	239. 7
	1870	640, 321	252	† 9, 258, 545	36, 083, 405	5, 734, 004	69	186. 5
	1860	522, 634	305	....	28, 052, 551	1, 848, 557	....	165. 2
	1850	294, 671	346	....	12, 526, 543	1, 278, 225	....	132. 6
Michigan	1890	497, 611	238	224, 537, 488	52, 343, 212	5, 370, 460	101	451. 2
	1880	384, 578	235	* 7, 898, 273	38, 865, 106	3, 953, 585	74	324. 7
	1870	250, 859	127	† 2, 277, 122	24, 400, 185	2, 301, 801	30	304
	1860	179, 543	240	....	15, 503, 482	1, 641, 897	....	269. 7
	1850	99, 676	250	....	7, 065, 878	1, 011, 492	....	224. 5
Wisconsin	1890	792, 620	470	303, 701, 134	60, 355, 499	54, 614, 861	966	383. 1
	1880	478, 374	364	* 25, 156, 977	33, 842, 336	19, 535, 324	414	267. 3
	1870	308, 377	292	† 2, 059, 105	22, 473, 036	3, 288, 581	54	231. 3
	1860	203, 001	262	....	13, 611, 328	1, 104, 300	....	207. 5
	1850	64, 339	211	....	3, 633, 750	400, 283	....	176. 7
Minnesota......	1890	593, 908	456	182, 968, 973	48, 677, 504	4, 292, 170	115	308. 1
	1880	275, 545	353	* 1, 504, 407	19, 244, 835	985, 329	27	216. 3
	1870	121, 467	276	† 208, 130	9, 522, 010	271, 477	2	239. 1
	1860	40, 344	235	....	2, 957, 673	199, 314	....	225. 7
	1850	607	101	....	1, 100	....	....	5. 4
Iowa............	1890	1, 498, 418	784	486, 961, 411	126, 036, 219	5, 743, 934	500	324. 9
	1880	854, 187	526	* 15, 965, 612	61, 665, 071	3, 852, 801	244	215

* "Milk sold or sent to butter and cheese factories, gallons," census, 1880.
† "Milk sold from farms, gallons," census, 1870.
a Cheese factories only.

TABLE III.—*Progress of dairying in the United States*—Continued.

[United States Census statistics for half a century.]

States and Territories.	Year of census.	Milch cows.		Milk, product reported.	Butter, total made.	Cheese, total made.	Creameries and cheese factories.	Milk, average yield per cow.
		Total number.	Per 1,000 persons.					
North Central Division—Continued.				*Gallons.*	*Pounds.*	*Pounds.*	*Number*	*Gallons.*
Iowa (Cont'd)...	1870	369, 811	310	† 688, 800	27, 512, 179	1, 344, 647	14	228. 5
	1860	189, 802	281	....	11, 953, 666	918, 635	....	194. 6
	1850	45, 704	238	....	2, 171, 188	209, 840	....	147. 9
Missouri........	1890	851, 076	318	193, 931, 103	44, 638, 168	1, 673, 017	68	227. 8
	1880	661, 405	305	* 3, 173, 017	28, 712, 988	873, 549	30	134. 9
	1870	398, 515	232	† 857, 704	14, 455, 825	213, 865	1	111. 6
	1860	345, 243	292	....	12, 704, 837	259, 633	....	111. 3
	1850	230, 169	337	....	7, 834, 359	203, 572	....	103. 1
North Dakota..	1890	88, 289	482	26, 566, 112	6, 158, 862	180, 374	10	300. 8
South Dakota...	1890	210, 240	639	59, 666, 525	13, 659, 757	554, 763	16	283. 8
Dakota Ter.....	1880	40, 572	301	* 415, 119	2, 006, 755	40, 137	4	159. 3
	1870	4, 151	297	....	209, 735	1, 850	0	152. 1
	1860	286	57	....	2, 170	....	....	22. 8
Nebraska.......	1890	505, 045	477	144, 768, 263	33, 894, 861	1, 268, 449	58	286. 6
	1880	161, 187	357	* 625, 783	9, 790, 970	554, 772	21	186. 6
	1870	28, 940	235	† 95, 059	1, 539, 535	78, 542	5	164. 7
	1860	6, 995	241	....	342, 541	12, 342	....	149
Kansas.........	1890	741, 786	520	201, 608, 099	50, 434, 952	2, 733, 346	101	271. 7
	1880	418, 333	420	* 1, 360, 235	21, 683, 244	1, 275, 371	48	160.
	1870	123, 440	339	† 196, 662	5, 022, 758	241, 607	1	125. 8
	1860	28, 550	267	....	1, 093, 497	29, 045	....	116. 1
South Central Division	1890	2, 829, 657	258	519, 693, 663	135, 302, 951	349, 667	22	183. 6
	1880	2, 147, 440	241	* 6, 084, 788	74, 208, 771	276, 923	10	....
	1870	1, 494, 434	232	† 2, 811, 323	34, 062, 404	311, 498	4	....
	1860	1, 859, 117	....	....	44, 132, 365	644, 416	....	....
	1850	1, 356, 491	....	....	31, 324, 361	571, 582	....	....
Kentucky	1890	364, 516	196	118, 497, 289	29, 038, 406	64, 822	15	325
	1880	301, 882	183	* 2, 513, 209	18, 261, 004	58, 468	8	189. 5
	1870	247, 615	187	† 1, 345, 779	11, 874, 978	361, 219	4	149. 9
	1860	269, 215	233	....	11, 716, 609	190, 400	....	131. 4
	1850	247, 475	252	....	9, 947, 523	213, 954	....	121. 6
Tennessee	1890	345, 311	195	107, 657, 116	28, 380, 377	101, 219	4	311. 6
	1880	303, 900	197	* 1, 006, 795	17, 889, 969	107, 740	2	180. 3
	1870	243, 197	193	† 415, 786	9, 571, 069	142, 240	0	120. 5
	1860	249, 514	225	....	10, 017, 787	135, 575	....	121. 1
	1850	250, 456	250	....	8, 139, 585	177, 681	....	98. 3
Alabama........	1890	292, 088	193	55, 508, 687	14, 548, 435	6, 131	0	190
	1880	271, 443	215	* 267, 387	7, 997, 719	14, 091	0	89. 4
	1870	170, 640	171	† 104, 657	3, 213, 753	2, 732	....	57. 1
	1860	230, 537	239	....	6, 028, 478	15, 923	....	78. 5
	1850	227, 791	295	....	4, 008, 811	31, 412	....	53
Mississippi.....	1890	310, 159	240	50, 803, 371	12, 988, 637	4, 898	0	163. 7
	1880	268, 178	237	* 427, 492	7, 454, 657	4, 239	0	85
	1870	173, 899	210	† 17, 052	2, 613, 521	3, 099	0	45. 2
	1860	207, 646	263	....	5, 006, 610	4, 427	....	72. 4
	1850	214, 231	353	....	4, 346, 234	21, 191	....	61
Louisiana.......	1890	167, 223	149	12, 881, 927	2, 089, 774	3, 939	0	77
	1880	146, 454	156	* 256, 241	916, 089	7, 618	0	20. 6
	1870	102, 076	140	† 833, 928	322 405	11, 747	0	17. 8
	1860	129, 662	183	....	1, 444, 742	6, 153	....	33. 5
	1850	105, 576	204	....	683, 069	1, 957	....	19. 4
Texas	1890	1, 003, 439	449	118, 475, 320	32, 145, 249	145, 730	3	118
	1880	606, 176	381	* 1, 296, 806	13, 899, 320	58, 466	0	71
	1870	428, 048	523	† 62, 771	3, 712, 747	34, 342	0	26. 3
	1860	601, 540	996	....	5, 850, 583	275, 128	....	29. 7
	1850	217, 811	1, 023	....	2, 344, 900	95, 299	....	32. 8
Oklahoma.......	1890	16, 756	270	1, 544, 280	387, 920	1, 600	0	92. 1
Arkansas.......	1890	330, 165	293	54, 325, 673	15, 724, 144	21, 328	0	164. 5
	1880	249, 407	311	* 316, 858	7, 790, 013	26, 301	0	95. 1
	1870	128, 959	266	† 31, 350	2, 753, 931	2, 119	....	64. 3
	1860	171, 003	393	....	4, 067, 556	16, 810	....	71. 5
	1850	93, 151	444	....	1, 854, 239	30, 088	....	60. 1
Western Division ..	1890	720, 767	238	202, 549, 207	44, 166, 290	6, 519, 870	52	281
	1880	422, 093	239	* 13, 804, 068	23, 296, 799	4, 806, 063	268	....
	1870	312, 775	316	† 4, 043, 087	11, 144, 030	3, 666, 907	3	....
	1860	315, 520	....	....	4, 585, 289	1, 551, 785	....	....
	1850	29, 203	....	....	295, 589	73, 976	....	....
Montana......	1890	24, 143	183	6, 038, 096	1, 062, 185	11, 512	1	250
	1880	11, 308	290	* 41, 165	412, 738	80, 070	3	116. 5
	1870	12, 432	592	† 105, 186	408, 080	27, 603	1	109. 3

* "Milk sold or sent to butter and cheese factories, gallons," census, 1880.
† "Milk sold from farms, gallons," census, 1870.

TABLE III.—*Progress of dairying in the United States*—Continued.

[United States Census statistics for half a century.]

States and Territories.	Year of census.	Milch cows. Total number.	Milch cows. Per 1,000 persons.	Milk, product reported.	Butter, total made.	Cheese, total made.	Creameries and cheese factories.	Milk, average yield per cow.
Western Division—Continued.				*Gallons.*	*Pounds.*	*Pounds.*	*Number*	*Gallons.*
Wyoming	1890	11,634	192	3,064,588	428,269	15,196	1	262.2
	1880	3,730	178	*75,343	105,643	2,930	0	106.1
	1870	707	79	†4,980	1,200	....	0	12.1
Colorado	1890	76,948	187	19,680,791	3,621,086	131,683	6	255.7
	1880	28,770	148	*506,706	862,479	75,367	2	107.8
	1870	25,017	625	†19,520	392,920	37,626	1	49.5
New Mexico	1890	18,507	120	717,155	860,042	18,931	0	38.7
	1880	12,955	108	*10,036	44,827	10,501	0	12.1
	1870	16,417	178	†813	12,912	27,239	0	4.3
	1860	34,369	366	....	13,259	37,240	....	2.4
	1850	10,635	172	....	111	5,848	....	.7
Arizona	1890	4,874	81	709.225	115,203	10,855	0	145.5
	1880	9,156	229	*42,618	62,217	62,217	2	27.2
	1870	938	94	†4,800	800	14,500	0	25.7
Utah	1890	45,982	221	8,614,694	1,815,154	176,739	3	187.3
	1880	32,768	228	*155,263	1,064,923	266,749	11	105.6
	1870	17,563	202	†11,240	310,335	69,603	0	58.3
	1860	11,967	299	....	316,046	53,331	....	84.4
	1850	4,861	442	....	83,309	30,998	....	58.9
Nevada	1890	9,273	202	2,532,052	489,657	51,207	1	273
	1880	13,319	215	*149,889	338.688	17,420	2	88.3
	1870	6,174	147	†63,850	110,880	....	0	64.2
	1860	947	135	....	7,700	....	....	24.4
Idaho	1890	27,278	325	5,085,863	1,091,753	323,853	4	186.4
	1880	12,838	389	*15,627	814,244	117,295	6	75.7
	1870	4,171	278	†11,250	111,480	4,464	0	84.1
Washington	1890	70,721	203	19,873,281	3,483,725	320,981	3	281
	1880	27,622	368	*226,703	1,404,066	179,200	2	160.1
	1870	16,938	706	†21,060	407,306	17,465	0	74.6
	1860	9,660	805	....	153,092	12,146	....	49
Oregon	1890	114,156	363	25,042,276	4,924,745	496,116	12	219.3
	1880	59,549	340	*227,540	2,528,225	299,732	24	129.9
	1870	48,325	531	†107,367	1,418,373	119,383	1	92.2
	1860	53,170	1,022	....	1,000,157	105,379	....	58.7
	1850	9,427	725	....	211,464	36,980	....	71.9
California	1890	317,201	263	111,191,186	27,048,471	4,962,797	21	350.5
	1880	210,078	243	*12,353,178	16,158,749	3,720,739	216	274.2
	1870	164,093	293	†3,693,021	7,969,744	3,395,074	0	192.4
	1860	205,407	541	....	3,095,035	1,343,689	....	52.8
	1850	4,280	46	....	705	150	....	.5

* "Milk sold or sent to butter and cheese factories, gallons," census, 1880.
† "Milk sold from farms, gallons," census, 1870.

NOTE.—Table III is taken entire from census reports excepting the last column. In that the figures for 1890 are computed from the census, and those for the other years are quoted from reports of the Department of Agriculture.

The column of "average milk yield per cow" shows an increase, decade after decade, which indicates a rapid improvement in cows. But these figures are misleading, because their basis varies for different years. In the earlier censuses the milk yield was not reported. For 1850 and 1860 only the butter and cheese made on farms were given, and the average milk yield per cow estimated erroneously by reducing the reported products to an equivalent in milk and dividing by the number of cows. The cows were thus credited with only such milk as was made into butter and cheese. For 1870 and 1880 the same plan was followed, but milk sold being also reported, this was added to that manufactured on farms; the large quantity of milk consumed on farms was still omitted from the computation. For 1890 the census reported the total milk product for the first time; this being directly divided by the number of producing cows, gives the annual average yield per cow, which should be accurate. Yet even for 1890 the yield appears unreliable in some cases. In the States of Connecticut, Massachusetts (480 gallons), Michigan (451), New York (461), Ohio, and Rhode Island the yield per cow appears to be above 400 gallons per year, while other States which carry just as good cows show a much lower average, and some States are so reported as to allow less than a gallon of milk per day per cow for a milking period limited to three or four months. Liberal allowances must be made in accepting such figures, although they are the best available.

DIAGRAM C.—*Cheese and butter production—five census years.*

[Factory and creamery production are shaded.]

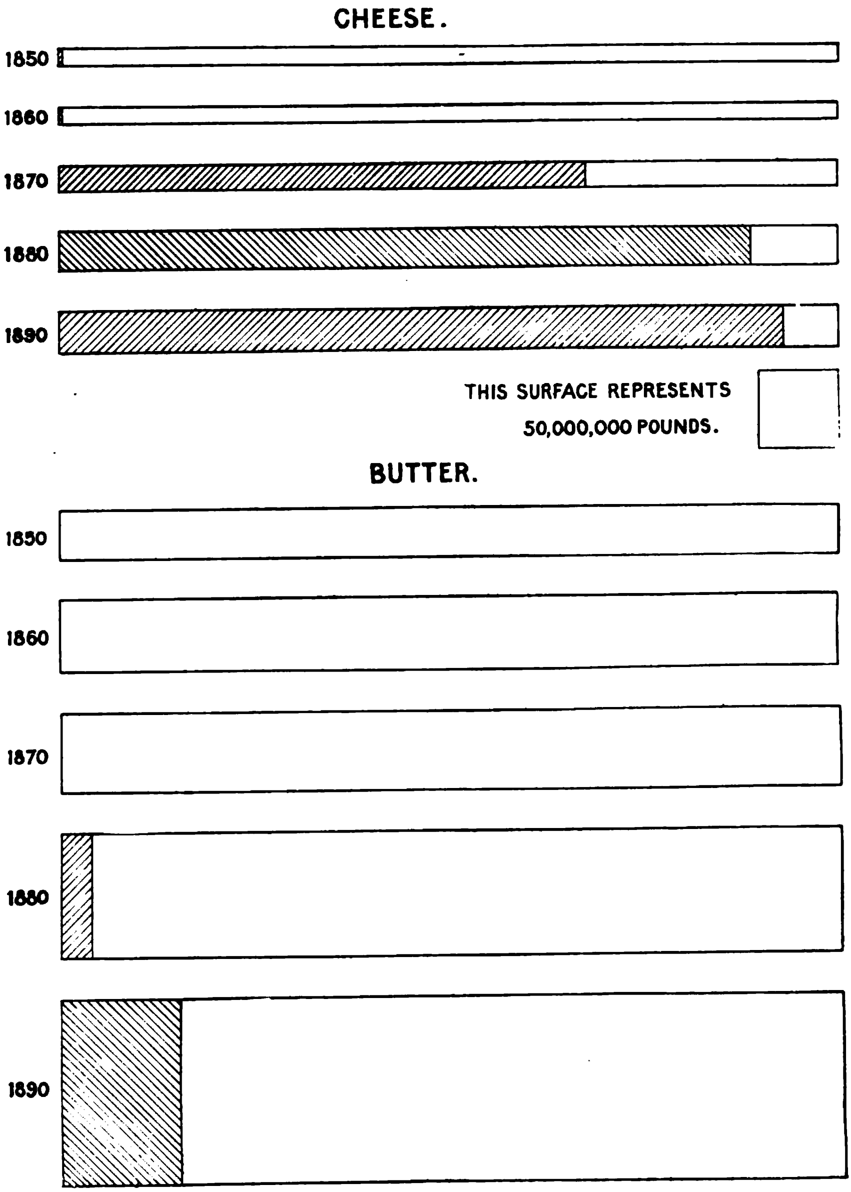


TABLE IV.—*Butter, cheese, and condensed-milk factories, including all "creameries."*

[From the census of the United States for 1890, 1880, and 1870.]

NOTE.—Urban establishments were separately reported from 20 different States in 1890, but incompletely, as shown below. None such reported in 1880.

Totals for the United States.	1890.	Urban establishments, 1890.	1880.	1870.
Number of establishments reporting	4, 552	160	3, 932	1, 313
Capital employed, aggregate ....dollars..	16, 016, 573	607, 590	9, 604, 803	3. 690, 075
Plant, total value ....do	11, 639, 692	449, 880		
Land ....do	968, 333	145, 692		
Buildings ....do	5, 588, 257	150, 149		
Machinery ....do	5, 083, 102	154, 039		
Live assets ....do	4, 376, 881	157, 710		
Expenses, total annual ....do	813, 954	61, 228		
Employees ....average number..	14, 369	552	7, 903	4, 607
Total wages paid ....dollars..	5, 116, 005	274, 700	1, 546, 495	706, 566
Earnings of skilled operatives, weekly:				
Average for males above 16 years..do....	9. 48			
Average for females above 15 years.do....	5. 35			
Average for children ....do	2. 75			
Hours of labor, daily average:				
May to November ....hours ..	11. 09			
November to May ....do	10. 03			
Materials used:				
Aggregate cost ....dollars..	49, 819, 301	1, 545, 273	18, 363, 579	14, 089, 284
For butter—				
Gathered cream ....pounds..	483, 630, 741			
Milk ....do....	1, 893, 310, 242			
Total cost ....dollars..	29, 538, 827		4, 644, 214	
For cheese—				
Milk ....pounds..	2, 684, 550, 517			
Total cost ....dollars..	16, 953, 992		12, 692, 507	14, 089, 284
For condensed milk—				
Milk ....pounds..	83, 617, 655			
Sugar ....do....	13, 372, 365			
Total cost ....dollars..	2, 792, 086		1, 926, 858	
Fuel and rented power, cost ....do....	534, 396			
Products:				
Aggregate value ....do....	60, 635, 705	2, 050, 338	25, 815, 963	16, 771, 665
Butter made—				
Quantity ....pounds..	181, 284, 916		29, 421, 784	
Value ....dollars..	36, 675, 411		6, 535, 799	
Cheese, full cream—				
Quantity ....pounds..	184, 158, 174			
Value ....dollars..	16, 112, 871			
Cheese, skim—				
Quantity ....pounds..	22, 467, 132			
Value ....dollars..	1, 230, 297			
Cheese, all other made—				
Quantity ....pounds..	31, 409, 759			
Value ....dollars..	2, 459, 783			
Cheese, total made—				
Quantity ....pounds..	238, 035, 065		215, 885, 361	109, 435, 229
Value ....dollars..	19, 802, 951		17, 659, 123	16, 710, 569
Condensed milk—				
Quantity ....pounds..	37, 926, 821		13, 033, 267	
Value ....dollars..	3, 586, 927		1, 547, 588	
Skim milk and all other products, value, dollars	570, 416		73, 453	61, 096

NOTE.—In this table the figures in the column for 1870 relate to cheese factories, no other product being reported. The column for 1880 requires no explanation except that at this time butter factories or creameries had become numerous, although their product was but little more than one-third in value of the factory cheese produced. For 1890 there are two columns, as the "urban establishments" for making butter and cheese were dealt with by the census separately from the butter and cheese factories in general.

It should be noted that these figures are from the "number of establishments reporting." It is known that, in fact, there were a good many more creameries in operation in the country in 1889–90 than the number reported in the table. The aggregate products of factory-made butter and cheese thus shown must be considerably less than the actual output of existing factories. The census returns of total dairy products of the United States for 1889 must, therefore, be below the actual facts.

This table, although thus incomplete, shows the rapid growth of the cooperative or factory system of dairying. Farm cheese making has practically disappeared since the advent of cheese factories and creameries, and the proportion of factory-made butter is fast increasing, although the quantity of butter made on farms is increasing also.

In 1890 the number of creameries, etc., reported by the census for New York allows one for every 36 square miles in the State. These factories thus averaged but 6 miles apart, giving the longest average drive for their patrons as about 4 miles.

Iowa reported 500 creameries in 1890, and State officials give 774 as the number for 1895. The latter gives one factory to every 72 square miles, an average of about 8 miles apart.

As to the 4,552 suburban factories reporting in 1890, it appears that these establishments averaged 4,261 pounds of milk per day as the material used at each creamery or factory. The average number of employees was 3½ to a factory. The combined factories reporting handled about 17 per cent of all the milk (reported) produced on the farms of the United States.

In connection with this table, attention is called to the Diagrams B and C.

TABLE V.—*Number and value of milch cows in the United States, and of other farm animals, yearly, 1870 to 1895, inclusive, with a few earlier years.*

[From the annual reports of the Department of Agriculture.]

Year.	Milch cows.		Oxen and other cattle.		Horses.		Total value of farm animals.
	Number.	Value.	Number.	Value.	Number.	Value.	
1840	4,837,043	$72,555,000	10,171,586	....	4,335,669	....	....
1850	6,385,094	127,840,880	11,393,813	....	4,336,719	....	$544,180,516
1860	8,585,735	264,643,375	17,034,284	....	6,249,174	....	1,089,329,915
1870	10,095,600	394,940,745	15,388,500	$346,926,440	8,248,800	$671,319,461	1,822,327,377
1871	10,023,000	374,179,093	16,212,200	369,940,056	8,702,000	683,257,587	1,810,142,711
1872	10,303,500	329,408,983	16,389,800	321,562,693	8,990,900	659,707,916	1,659,211,933
1873	10,575,900	314,358,931	16,413,800	329,298,755	9,222,470	684,463,957	1,684,431,693
1874	10,705,300	299,609,309	16,218,100	310,649,803	9,333,800	666,927,406	1,619,944,472
1875	10,906,800	311,089,824	16,313,400	304,858,859	9,504,200	646,370,939	1,618,012,221
1876	11,085,400	320,346,728	16,785,300	319,623,509	9,735,300	632,446,985	1,647,719,138
1877	11,260,800	307,743,211	17,956,100	307,105,386	10,155,400	610,206,631	1,576,506,083
1878	11,300,100	298,499,866	19,223,300	329,541,703	10,329,700	600,813,681	1,574,620,783
1879	11,826,400	256,953,928	21,408,100	329,543,327	10,938,700	573,254,808	1,445,423,062
1880	12,027,000	279,899,420	21,231,000	341,761,154	11,201,800	613,296,611	1,576,917,556
1881	12,368,653	296,277,060	20,937,702	362,861,509	11,429,626	667,954,325	1,721,795,252
1882	12,611,632	326,489,310	23,280,238	463,069,499	10,521,554	615,824,914	1,906,468,250
1883	13,125,685	396,575,405	28,046,077	611,549,109	10,838,111	765,041,308	2,338,215,268
1884	13,501,206	423,486,649	29,046,101	683,229,054	11,169,683	833,734,400	2,467,868,924
1885	13,904,722	412,903,093	29,866,573	694,382,913	11,564,572	852,282,947	2,456,428,383
1886	14,235,388	389,985,523	31,275,242	661,956,274	12,077,657	860,823,208	2,365,159,862
1887	14,522,083	378,789,589	33,511,750	663,137,926	12,496,744	901,685,755	2,400,586,938
1888	14,856,414	366,252,173	34,378,363	611,750,520	13,172,936	946,096,154	2,409,043,418
1889	15,298,625	366,226,376	35,032,417	597,236,812	13,663,294	982,194,827	2,507,050,058
1890	15,952,883	353,152,133	36,849,024	560,625,137	14,213,837	978,516,562	2,418,766,028
1891	16,019,591	346,397,900	36,875,648	544,127,908	14,056,750	941,823,222	2,329,787,770
1892	16,416,351	351,378,132	37,651,239	570,749,155	15,498,140	1,007,593,636	2,461,755,698
1893	16,424,087	357,299,785	35,954,196	547,882,204	16,206,802	992,225,185	2,483,506,681
1894	15,487,400	358,998,661	36,608,168	536,789,747	16,081,139	769,224,799	2,170,816,754
1895	16,504,629	362,601,729	34,364,216	482,999,129	15,893,318	576,730,580	1,817,802,110

NOTE.—Some of the figures above agree exactly with those of the census for the corresponding year. In other cases, for census years, the numbers of animals as reported by the Department differ somewhat from those of the census.

TABLE VI.—*Cattle statistics (additional) by States.*

[From the Eleventh United States Census.]

States and Territories.	Neat cattle on farms, June 1, 1890.				Percentage according to quality or breeding.		
	Total oxen, cows, and other cattle.	Quality or breeding.					
		Pure-bred recorded.	Grade one-half blood or higher.	Common native or low-grade.	Pure-bred.	Grades one-half or over.	Common or native.
The United States	51,363,572	506,060	8,257,989	42,599,523	.99	16.08	82.93
North Atlantic Division	5,461,724	96,661	896,528	4,468,535	1.77	16.41	81.82
Maine	299,110	5.506	79,542	214,062	1.84	26.59	71.57
New Hampshire	222,888	3,542	42,679	176.667	1.59	19.15	79.26
Vermont	395,288	6.306	90,929	298,053	1.60	23	75.40
Massachusetts	256.128	8.473	65.655	182,000	3.31	25.63	71.06
Rhode Island	34,777	1,248	9,697	23.832	3.59	27.88	68.53
Connecticut	203,661	7,424	43,914	152.323	3.65	21.56	74.79
New York	2,131,392	32.053	327,972	1,771,367	1.50	15.39	83.11
New Jersey	212,062	6,480	36,843	168,739	3.06	17.37	79.57
Pennsylvania	1,706,418	25,629	199,297	1,481,492	1.50	11.68	86.82
South Atlantic Division	3,890,107	28,293	288,420	3,573,394	.73	7.41	91.86
Delaware	51,844	1,018	9,651	41,175	1.96	18.62	79.42
Maryland	267,189	6,225	47,442	213,522	2.33	17.76	79.91
District of Columbia	988	59	233	696	5.97	23.58	70.45
Virginia	747,334	7,291	110,946	629,097	.97	14.85	84.18
West Virginia	566,066	3,042	41,971	521.053	.54	7.41	92.05
North Carolina	630,903	3,461	31,474	595,968	.55	4.99	94.46
South Carolina	268,293	2,053	12,544	253,696	.76	4.68	94.56
Georgia	873,926	3,931	28,148	841,847	.45	3.22	96.33
Florida	483,564	1,213	6,011	476,340	.25	1.24	98.51
North Central Division	24,572,400	297,303	5,457.320	18,817,777	1.21	22.21	76.58
Ohio	1,763,387	36,465	433,849	1,293,073	2.07	24.60	73.33
Indiana	1,511,908	23,538	294,954	1,193,416	1.56	19.51	78.93
Illinois	3,063,119	42,872	752,556	2,267,691	1.40	24.57	74.03
Michigan	1,046,771	17,468	230,310	798,993	1.67	22	76.33
Wisconsin	1,647,947	13,866	205,021	1,429,060	.84	12.44	86.72
Minnesota	1,373,579	10,825	134,397	1,228,357	.79	9.78	89.43
Iowa	4,895,550	60,295	1.463,856	3,371,399	1.23	29.90	68.87
Missouri	2,969,716	38,443	696,046	2,235,227	1.29	23.44	75.27
North Dakota	281,874	1,996	33,774	246,104	.71	11.98	87.31
South Dakota	687,919	4,527	74,468	608,924	.66	10.82	88.52
Nebraska	2,142,597	17,593	392,326	1,732,678	.82	18.31	80.87
Kansas	3,188,033	29,415	745,763	2.412,855	.92	23.39	75.69
South Central Division	11,724,483	54,260	793,609	10,876,614	.46	6.77	92.77
Kentucky	1,066,091	16,172	157.503	892,416	1.52	14.77	83.71
Tennessee	965,339	9,844	112,443	843,052	1.02	11.65	87.33
Alabama	875,976	2,767	22,519	850,690	.32	2.57	97.11
Mississippi	914,778	3.217	23,595	887,966	.35	2.58	97.07
Louisiana	581.103	1,436	10,050	569,617	.25	1.73	98.02
Texas	6,201,552	17,971	430.334	5,753,247	.29	6.94	92.77
Oklahoma	126.955	384	13,876	112,695	.30	10.93	88.77
Arkansas	992,689	2,469	23,289	966.931	.25	2.35	97.40
Western Division	5,714,858	29.543	822,112	4,863,203	.52	14.39	85.09
Montana	691,898	3,574	69,387	618.937	.52	10.03	89.45
Wyoming	685,969	1,918	59,497	624,554	.28	8.67	91.05
Colorada	717,861	5,524	240,340	471,997	.77	33.48	65.75
New Mexico	577,511	559	89,408	487,544	.10	15.48	84.42
Arizona	268,122	223	14,813	253.086	.08	5.53	94.39
Utah	200,266	2,501	26,560	171,205	1.25	13.26	85.49
Nevada	210,900	807	19,621	190.472	.38	9.30	90.32
Idaho	219,431	1,285	10,226	207,920	.59	4.66	94.75
Washington	255,134	2,129	20,809	232.196	.83	8.16	91.01
Oregon	520,648	3,687	39,965	476,996	.71	7.08	91.61
California	1,367,118	7,336	231,486	1,128,296	.54	16.93	82.53

DIAGRAM D.—*Number of cows in each State and Territory according to the Eleventh Census.*

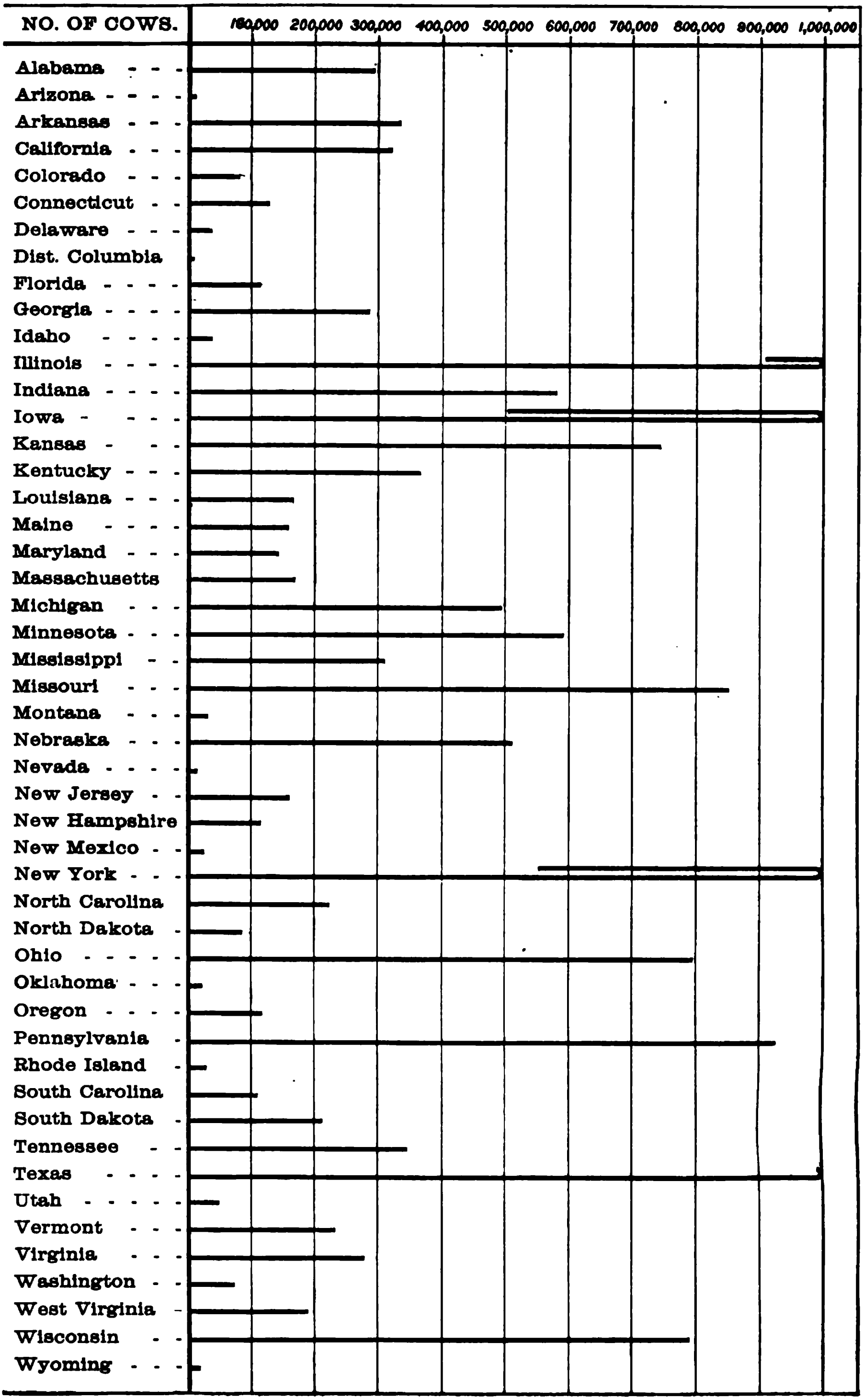


TABLE VII.—*Farm statistics by States.*

[From the Eleventh United States Census, 1890.]

States and Territories.	Population.	Persons "in agriculture."	Farms.	Average size of farms.	Milch cows.	All other neat cattle.
				Acres.		
The United States	62, 622, 250	8, 477, 691	4, 564, 641	137	16, 511, 950	34, 851, 622
North Atlantic Division	17, 401, 545	1, 080, 030	658, 569	95	3, 351, 061	2, 110, 663
Maine	661, 086	78. 517	62, 013	100	157, 278	141, 832
New Hampshire	376, 530	41, 285	29, 151	119	109, 423	113, 465
Vermont	332, 422	53, 505	32, 573	135	231, 419	163, 869
Massachusetts	2, 238, 943	69, 116	34, 374	87	172, 046	84, 032
Rhode Island	345, 506	11, 576	5, 500	85	23, 948	10, 834
Connecticut	746, 258	45, 243	26, 350	86	127, 802	75, 769
New York	5, 997, 853	396. 505	226, 223	97	1, 440, 230	691, 162
New Jersey	1, 444, 933	68, 040	30, 828	86	161, 576	50, 486
Pennsylvania	5, 258, 014	316, 243	211, 557	87	927, 254	779, 164
South Atlantic Division	8, 857, 920	1, 641, 959	749, 600	134	1, 369, 466	2, 520, 641
Delaware	168, 493	18, 099	9, 381	113	32, 574	19, 270
Maryland	1, 042, 390	90, 563	40, 798	121	142, 198	124, 991
District of Columbia	230, 392	1, 706	382	31	863	125
Virginia	1, 655, 980	257, 372	127, 600	150	273, 634	473, 700
West Virginia	762, 794	118, 623	72, 773	142	188, 492	377, 574
North Carolina	1, 617, 947	364, 955	178, 359	127	223, 416	407, 487
South Carolina	1, 151, 149	322, 887	115, 008	115	107, 184	161, 109
Georgia	1, 837, 353	404, 995	171, 071	147	287, 717	586, 209
Florida	391, 422	62, 759	34, 228	107	113, 388	370, 176
North Central Division	22, 362, 279	3, 086, 618	1, 923, 822	133	8, 240, 999	16, 331, 401
Ohio	3, 672, 316	398, 877	251, 430	93	794, 833	968, 554
Indiana	2, 192, 404	320, 435	198, 167	103	579, 287	932, 621
Illinois	3, 826, 351	430, 795	240, 681	127	1, 087, 886	1, 975, 233
Michigan	2, 093, 889	274, 000	172, 344	86	497, 611	549, 160
Wisconsin	1, 686, 880	231, 311	146, 409	115	792, 620	855, 327
Minnesota	1, 301, 826	188, 405	116, 851	160	593, 908	779, 671
Iowa	1, 911, 896	322, 664	201, 903	151	1, 498, 418	3, 397, 132
Missouri	2, 679, 184	387, 535	238, 043	129	851. 076	2, 118, 640
North Dakota	182, 719	43, 843	27, 611	277	88 289	193, 585
South Dakota	328, 808	68, 154	50, 158	227	210, 240	477, 679
Nebraska	1, 058, 910	170, 058	113, 608	190	505, 045	1, 637, 552
Kansas	1, 427, 096	250, 541	166, 617	181	741, 786	2, 446, 247
South Central Division	10, 972, 893	2, 306, 883	1, 086, 772	144	2, 829, 657	8, 894, 826
Kentucky	1, 858, 635	318, 624	179, 264	119	364, 516	701, 575
Tennessee	1, 767, 518	328, 750	174, 412	116	345, 311	620, 028
Alabama	1, 513, 017	369, 498	157, 772	126	292, 088	583, 888
Mississippi	1, 289, 600	358, 094	144, 318	122	310, 159	604, 619
Louisiana	1, 118, 587	236, 138	69, 294	138	167 223	413, 880
Texas	2, 235, 523	428, 097	228, 126	225	1, 003, 439	5, 198, 113
Oklahoma	61, 834	13, 889	8, 826	182	16, 756	110, 199
Arkansas	1, 128, 179	253, 793	124, 760	119	330, 165	662, 524
Western Division	3, 027, 613	337, 328	145, 878	324	720, 767	4, 994, 091
Montana	132, 159	13, 635	5, 603	351	24, 143	667, 755
Wyoming	60, 705	7, 894	3, 125	586	11, 684	674, 285
Colorado	412, 198	36, 730	16, 389	281	76. 948	640, 913
New Mexico	153, 593	23, 171	4, 458	177	18, 507	559, 004
Arizona	59, 620	6, 531	1, 426	910	4, 874	263, 248
Utah	207, 905	19, 761	10, 517	126	45, 982	154, 284
Nevada	45, 761	5, 126	1, 277	1, 301	9, 273	201, 627
Idaho	84, 385	13, 210	6, 603	197	27, 278	192, 153
Washington	349, 390	37, 547	18, 056	231	70, 721	184, 413
Oregon	313, 767	44, 521	25, 530	271	114, 156	406, 492
California	1, 208, 130	129, 202	52, 894	405	317, 201	1, 049, 917

COWS AND CATTLE OF FOREIGN COUNTRIES.

By R. A. PEARSON, B. S., *Assistant Chief of Dairy Division.*

Table VIII gives the number of cows and all cattle in countries where such statistics have been collected. In most cases an earlier and later date are given to show whether stock raising is increasing or decreasing. The figures are taken chiefly from official documents. Other sources of information are the reports of the statistician of the United States Department of Agriculture, the Statesman's Year Book, and "Agricultural Returns for Great Britain," which latter contains some statistics of the important European countries, as well as of British provinces. Sometimes equally reliable authorities differ. This may be due to reference to different times of the year, or one writer may include a province which the other omits.

In some countries where the number of cattle is very small in proportion to the population there are large numbers of buffalo, reindeer, goats, llamas, or other animals for the supply of milk and meat. The statistics of Japan show that cows are used in that country for transportation and tillage. Remembering these facts and the difference of development of dairying in different countries, it is evident that the number of cows alone does not show the condition of the dairy industry.

Considering the large amounts of our dairy products, the development of our dairy cattle, and the intensity of the industry in many sections, the United States is the leading dairy as well as stock-raising country. In certain small districts of Europe dairying is extensively and successfully carried on. It is not of much importance in sparsely inhabited and semicivilized countries.

Denmark is noted for the large amount of butter of fine quality which is made there. In Bulletin No. 5 of the United States Department of Agriculture, Bureau of Animal Industry, Prof. C. C. Georgeson gives the estimated butter yield of Denmark for 1891 and the number of cattle for 1888. From the available data it is estimated that there were 954,660 cows in Denmark in 1891, which was more than 65 per square mile, and above 439 per thousand persons. This small country is less than one-third the size of New York State, it has a denser population, more than twice as many cows per square mile, and produced in 1891 about five times as much butter per square mile as was made in New York. Its milk and cheese trade is comparatively small. The number of cows per square mile is about the same as in Orange County, N. Y. Nine States of the Union have more cows per thousand persons than Denmark.

In 1893 England and Wales each had about one and one-fifth as many cows per square mile as New York. Ireland, only two-thirds the size of New York, had about the same total number of cows. Wisconsin, which is twice as large as Scotland, had in 1893 as many cows per square mile as that country possessed in 1890.

Holland is a little smaller than Massachusetts and Connecticut together. It had in 1892 about two and one-half times as many cows per square mile as Iowa in 1890, and almost five times as many as Wisconsin in 1890, and as many cows per thousand persons as Kentucky.

France is four times as large as New York, and has as many cows per square mile. Germany is a little larger than France, and has about one and one-half times as many cows per square mile as New York.

Japan has a smaller number of cows per one thousand persons than any State or Territory, and in 1892 had less per square mile than North Carolina in 1890.

Australian butter has recently come into some prominence in our foreign markets, and it is interesting to note that the leading dairy colony of Australia, Victoria, which is about one and two-thirds times as large as North Carolina, or a little larger than Minnesota, had in 1892 less than 5 cows per square mile, and produced only about 275 pounds of butter per square mile, resembling in these respects North Carolina in 1890.

Canada is our chief competitor in the foreign cheese market. Recent statistics show that its dairy interests per square mile are comparatively small. The appendix to the report of the minister of agriculture for 1893 takes the following from the census of 1890:

	Number.	Capital.	Hands employed.	Wages paid.	Value of raw material.	Value of product.
Cheese factories	1,565	$2,586,599	3,013	$753,067	$6,804,611	$9,784,288
Creameries	170	540,598	425	106,303	595,421	913,591

From special schedules returned by 451 factories and creameries the following additional information is obtained (the numbers refer to the factory season):

	Average number of days operated.	Cows per factory.	Patrons per factory.	Cows per patron.	Pounds milk for 1 pound of product.	Price of product.	Price of 100 pounds milk at factory.
Cheese factories	177	337	50.55	6.67	10.14	$0.09+	$0.77
Creameries	183	330	60.89	5.42	25.26	.20+	.77—

	Average return for milk—		Average number of pounds milk per cow—		Average number of pounds product per cow—	
	Per cow.	Per patron.	Per season.	Per day.	Per season.	Per day.
Cheese factories	$19.65	$131.00	2,638	14.90	260.01	1.47
Creameries	18.09	98.10	2,362	12.34	93.54	.51

The following gives the butter and cheese production of Canada, 1890:

	Made in home dairies.	Made in factories.	Total production.
	Pounds.	*Pounds.*	*Pounds.*
Cheese	6, 267, 203	108, 714, 311	114, 981, 514
Butter	111, 370, 210	4, 567, 955	115, 938, 165

By comparing with the previous tables it will be seen that in 1890 the total cheese production of Canada was less than that of New York, and her butter production was slightly greater than that of New York, but less than that of Iowa.

During the ten years from 1880 to 1890 the production of cheese in Canada increased 80 per cent, and the production of butter 11 per cent. In the same period the cheese production of the United States increased less than 6 per cent, and the butter production 50 per cent. In the same time the number of cows increased 16 per cent in Canada, and over 32 per cent in the United States, and population increased 12 per cent in Canada and 25 per cent in this country. Wisconsin made large increases during this time, as is shown by the following:

Per cent increase in ten years of population, cows, butter, and cheese production in Canada, United States, and Wisconsin.

	Canada.	United States.	Wisconsin.
Population	12	25	28
Number of cows	16	32	66
Cheese production	80	6	180
Butter production	11	50	78

Ontario is the leading dairy province of Canada. It is about four times as large as Michigan and has less than one-half as many cows per square mile. It produces about one-fifth as much cheese per square mile as is made in New York. The 1,011 factories of Ontario made in 1894, 97,284,547 pounds of cheese, valued at $9,441,247, or 9.7 cents per pound; it required 10.56 pounds of milk for 1 pound of cheese. Patrons received an average of 77.2 cents for 100 pounds of milk. The average Ontario factory manufactures about 100,000 pounds of cheese in a season. In some counties where dairying is a leading branch of agriculture over $30 worth of cheese is produced per head of the rural population. In the same year, 1894, the 115 creameries made about 3,000,000 pounds of butter, valued at $628,200, or 20.94 cents per pound.

Manitoba has about the same area and character as North Dakota. It is now making rapid advances in dairying. Twelve of the 19 creameries and 20 of the 42 cheese factories have commenced operations within a year.

Nova Scotia is one-fourth as large as Nebraska. In 1891 these two had about the same number of cows per square mile.

In some countries detailed statistics of cattle are collected. German reports give the number of cattle of different ages, also the number of calves and the proportion of them it is expected will be raised. The agricultural returns for Great Britain give the number of cattle under 1 year, between 1 and 2 years, and over 2 years of age. An example of these details is given below.

Example of foreign cattle statistics—German Empire, 1885.

Horses:		Cattle:	
Colts under 1 year	190,022	Calves under 6 weeks	512,706
Colts 1 year and under 2 years	194,066	Calves 6 weeks to 6 months	1,183,133
Horses 2 years and under 3 years	175,367	Calves 6 months to 2 years	3,422,347
Total under 3 years	559,455	Total under 2 years	5,068,186
		Number to be raised as bulls	91,752
Horses 3 years and over:			
Stallions	13,882	Cattle 2 years old and over:	
Horses in agriculture	2,228,529	Breeding bulls	185,026
Horses in military service	107,147	Other bulls and oxen	1,445,204
All other over 3 years	613,303	Cows	9,086,906
Total 3 years and over	2,962,861	Total 2 years and over	10,717,136
Grand total	3,522,316	Grand total	15,785,322

Sheep (in three classes)—1, fine wooled· 2, mutton breeds; 3, all others. Lambs, yearlings and over 1 year, in each class.

TABLE VIII.—*Cows and cattle of foreign countries for stated years.*

[From various authorities.]

Countries.	Years.	Cows.	All cattle.	Years.	Cows.	All cattle.
Algeria	1880	....	1,163,513	1893	....	1,233,051
Argentina	1883	....	*12,000,000	1893	....	*22,000,000
Australasia	1884	....	*8,154,701	1892	1,249,720	12,343,853
Australia	1884	....	7,325,867	1892	994,707	11,351,967
New South Wales	1884	....	1,336,329	1892	365,110	2,147,074
Queensland	1884	....	4,266,172	1892	*125,000	6,591,416
South Australia	1884	....	389,726	1892	79,420	625,887
Victoria	1884	....	1,262,538	1892	417,177	1,824,704
Western Australia	1884	....	71,102	1892	*8,000	162,886
New Zealand	1881	....	698,637	1892	*220,000	821,801
Tasmania	1884	....	128,834	1892	35,013	170,085
Austria	1880	4,138,625	8,584,077	1890	4,254,303	8,643,936
Belgium	1880	796,178	1,382,815	....	....	....
Brazil	....	....	....	1891	....	*17,000,000
Canada	1881	1,595,800	3,434,781	1891	1,829,375	4,060,662
British Columbia	1881	10,878	80,451	1891	17,817	126,729
Manitoba	1881	20.355	60,281	1891	82,614	229,707
New Brunswick	1881	103,965	212,560	1891	104,797	202,439
Nova Scotia	1881	137,639	325,603	1891	135,043	309,776
Ontario	1881	782,243	1,702,167	1894	834,237	2,099,301
Quebec	1881	490,977	950,125	1891	546,986	970,887
Prince Edward Island	1881	45,895	90,722	1891	45,788	91,629
The Territories	1881	3,848	12,872	1891	36,997	233,721
Cape of Good Hope	1875	....	1,329,445	1893	....	1,929,800
Ceylon	1884	....	963,896	1893	....	1,062,776
Chile	1882	....	311,000	....	....	....
Costa Rica	....	....	....	1892	....	345,665
Cuba	....	....	....	1892	....	2,485,766
Denmark	1881	898,790	1,470,078	1893	1,011,098	1,696,190
Egypt	1887	....	462,000	....	....	....
Finland	1888	....	966,511	1890	....	928,276
France	1881	7,290,827	11,576,190	1893	6,005,246	12,154,641
Germany	1883	9,087,293	15,786,764	1892	9,946,164	17,555,694
Greece	1877	....	279,445	(†)	....	337,000
Hungary	1880	2,035,217	5,311,378	1884	....	4,759,393
India	....	....	....	1890	....	49,635,590
Italy	1881	2,366,556	4,783,232	1890	....	*5,000,000
Jamaica	1883	....	84,206	1893	....	110,720
Japan	1887	598,104	1,020,222	1892	643,500	1,093,638
Netherlands	1880	908,000	1,469,600	1892	893,900	1,528,400
Newfoundland	1875	....	13,939	1891	....	23,822
Nicaragua	1884?	....	400,000	....	....	....
Norway	1875	741,598	1,016,617	1890	705,188	1,004,191
Orange Free State	1881	....	464,575	1890	....	*895,099
Paraguay	1882	....	500,000	1891	....	861,954
Poland	1888	....	3,013,392	....	....	....
Portugal	1882	....	624,658	....	....	....
Roumania	1880	....	*3,600,000	1890	....	2,520,380
Russia in Europe	1883	....	23,628,031	1888	....	24,609,260
Servia	1882	....	826,550	1891	....	819,251
Spain	1880	....	*2,460,253	....	....	....
Sweeden	1883	1,456,504	2,287,013	1893	1,647,400	2,473,981
Switzerland	1876	....	1,035,930	1886	....	1,212,538
United Kingdom	‡1881-85	3,762,931	10,225,379	1895	3,937,590	10,753,314
England	‡1881-85	1,687,166	4,324,641	1895	1,786,370	4,472,565
Ireland	1885	1,417,481	4,228,851	1895	1,433,960	4,358,041
Island of Jersey	....	....	....	1895	6,748	12,282
Island of Guernsey	....	....	....	1895	3,663	7,519
Isle of Man	....	....	....	1895	7,399	21,136
Scotland	‡1881-85	400,268	1,116,876	1895	423,967	1,177,947
Wales	‡1881-85	265.483	668,286	1895	275,483	703.824
United States	1885	13,904,722	43,771,295	1895	16,504,629	50,868,845
Uruguay	1883	....	6,010,000	1889	....	8,339,600
Venezuela	1888	....	8,476,300	....	....	....

* Official estimates. † Latest official returns, published 1894. ‡ Average.

TABLE IX.—*Population and number of cows per square mile of land surface in each State and Territory in 1890.*

	Persons.	Cows.		Persons.	Cows.		Persons.	Cows.
United States	21.08	5.56	Maine	22.11	5.26	Oklahoma	1.59	0.43
Alabama	29.36	5.62	Maryland	105.72	14.42	Oregon	3.32	1.20
Arizona	.53	.04	Massachusetts	278.48	21.40	Pennsylvania	116.88	20.61
Arkansas	21.27	6.23	Michigan	36.46	8.73	Rhode Island	318.44	22.06
California	7.75	2.03	Minnesota	16.44	7.52	South Carolina	38.16	3.55
Colorado	3.98	.74	Mississippi	27.83	6.74	South Dakota	4.28	2.73
Connecticut	154.03	26.40	Missouri	38.98	12.38	Tennessee	42.34	8.27
Delaware	85.97	16.62	Montana	.91	.17	Texas	8.52	3.83
Florida	7.22	2.10	Nebraska	13.78	6.57	Utah	2.53	.56
Georgia	31.15	4.88	Nevada	.42	.08	Vermont	36.39	25.33
Idaho	1	.32	N. Hampshire	41.81	12.16	Virginia	41.27	6.84
Illinois	68.33	19.43	New Jersey	193.82	21.67	Washington	5.22	1.06
Indiana	61.05	16.09	New Mexico	1.25	.15	West Virginia	30.95	7.65
Iowa	34.46	27.25	New York	125.95	30.24	Wisconsin	30.98	14.56
Kansas	17.47	9.04	North Carolina	33.30	4.60	Wyoming	.62	.12
Kentucky	46.47	9.11	North Dakota	2.60	1.26			
Louisiana	24.63	3.72	Ohio	90.10	19.50			

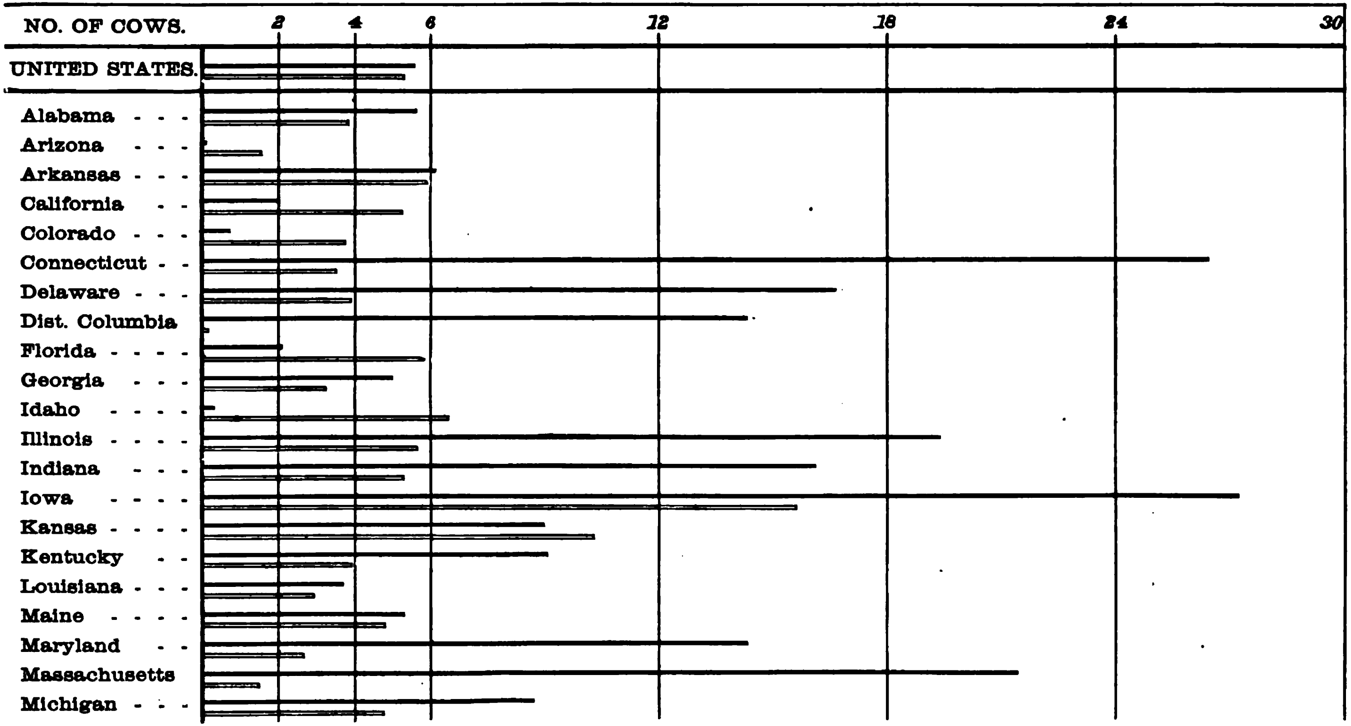
NOTE.—Diagram E, which follows on the next two pages, serves to illustrate Table IX. It shows graphically the number of cows per square mile and the number to each 20 persons; thus two lines are opposite the name of each State and Territory. Twenty persons are taken instead of 100, which might seem more natural, because that is nearly the number of persons to the square mile in the United States, and in the average for the whole country there would be almost as many cows per 20 persons as per square mile. When the upper line is long it indicates that the industry is highly developed, because a large number are carried on a small area. When the lower line is long it shows that dairying is a principal industry, because the number of cows is large in proportion to the population. For example, dairying is highly developed in New York, Iowa, and Connecticut, as is shown by the long upper lines, while the relative importance of the industry, as shown by the lower lines, is much greater in Iowa than in either of the other two. On the other hand, the lower lines for South Dakota, Nebraska, and Minnesota show dairying to be a leading industry, although the upper lines indicate that it is not highly developed in these States. It may be readily seen which States are above or below the average of the country by comparing the lines for any State with those for the whole country, which are at the top of the diagram.

TABLE X.—*Pounds of cheese and butter produced per square mile of land surface in each State and Territory in 1889.*

	Cheese.	Butter.		Cheese.	Butter.		Cheese.	Butter.
United States	86.45	405.90	Maine	48.56	568.64	Oklahoma	0.04	9.99
Alabama	.12	282.27	Maryland	2.39	1,100.09	Oregon	5.25	52.08
Arizona	.10	1.02	Mass	47.95	1,294.81	Pennsylvania	121.32	2,138.48
Arkansas	.40	296.43	Michigan	93.51	911.43	Rhode Island	299.20	1,105.28
California	31.82	173.41	Minnesota	54.19	614.58	S. Carolina	.08	190.17
Colorado	1.27	34.94	Mississippi	.11	280.29	S. Dakota	7.21	177.75
Connecticut	63.68	2,140.20	Missouri	24.34	649.42	Tennessee	2.42	679.77
Delaware	.18	1,272.07	Montana	.08	7.31	Texas	.56	122.56
Florida	.03	15.99	Nebraska	16.51	441.11	Utah	2.15	22.08
Georgia	.22	245.56	Nevada	.47	4.46	Vermont	677.82	3,108.86
Idaho	3.84	12.95	N. Hampshire	49.38	1,095.22	Virginia	5.44	467.59
Illinois	184.80	1,476.34	New Jersey	78.77	1,189.37	Washington	4.80	52.09
Indiana	33.18	1,396.68	New Mexico	.15	.70	W. Virginia	3.87	571.38
Iowa	103.54	2,271.95	New York	2,605.77	2,367.23	Wisconsin	1,003.03	1,108.46
Kansas	33.46	617.32	N. Carolina	1.25	270.26	Wyoming	.16	4.39
Kentucky	1.62	725.96	N. Dakota	2.57	87.74			
Louisiana	.09	46.01	Ohio	545.98	2,000.07			

DIAGRAM E.—*Number of cows per square mile and per 20 persons in each State and Territory, 1890.*

[The upper line (heavy) represents the number of cows per square mile. The lower line (open) represents the number of cows per 20 persons.]



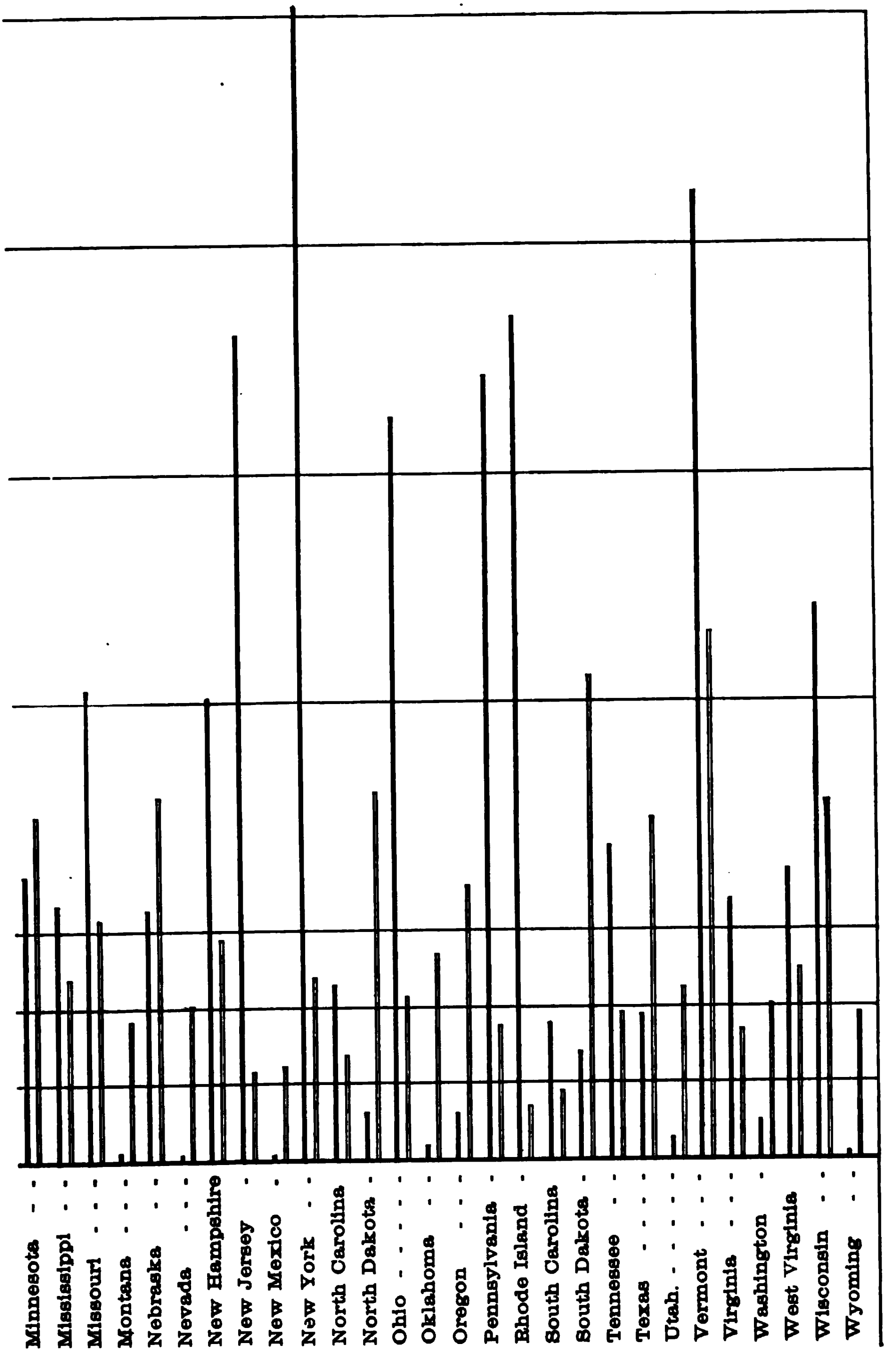

Minnesota
Mississippi
Missouri
Montana
Nebraska
Nevada
New Hampshire
New Jersey
New Mexico
New York
North Carolina
North Dakota
Ohio
Oklahoma
Oregon
Pennsylvania
Rhode Island
South Carolina
South Dakota
Tennessee
Texas
Utah
Vermont
Virginia
Washington
West Virginia
Wisconsin
Wyoming

TABLE XI.—*Rank of each State and Territory in 1890 in regard to—*

	Land area.	Population.	Persons in agriculture.	Number of cows.	Milk produced.	Butter produced.	Cheese produced.	Persons per square mile.	Cows per square mile.	Butter per square mile.	Cheese per square mile.
Alabama	26	17	7	19	24	21	42	25	27	27	41
Arizona	5	47	47	48	48	47	41	47	48	47	43
Arkansas	25	24	18	16	27	20	36	29	26	26	36
California	2	22	24	17	15	17	9	34	36	33	18
Colorado	7	31	38	37	36	35	29	38	40	39	32
Connecticut	46	29	33	31	26	29	24	4	3	4	11
Delaware	47	41	41	40	38	37	48	9	11	10	38
Florida	24	32	31	33	43	43	46	35	35	41	48
Georgia	19	12	3	20	28	22	39	22	29	30	37
Idaho	10	44	44	41	42	41	22	44	43	42	26
Illinois	21	3	1	3	4	4	4	10	10	7	6
Indiana	37	8	13	11	9	9	15	11	12	8	17
Iowa	22	10	12	1	2	1	6	20	2	3	8
Kansas	12	19	19	9	8	8	11	30	18	20	16
Kentucky	35	11	14	14	13	14	32	12	17	17	31
Louisiana	30	25	20	27	37	38	44	27	32	38	44
Maine	39	30	27	29	23	19	13	28	28	23	14
Maryland	41	27	26	30	30	27	35	7	14	14	29
Massachusetts	44	6	28	26	18	28	20	2	7	9	15
Michigan	20	9	16	13	7	7	8	18	19	16	9
Minnesota	13	20	22	10	11	10	10	31	22	21	12
Mississippi	29	21	9	18	29	26	43	26	24	28	42
Missouri	17	5	6	6	10	11	12	16	15	19	19
Montana	3	43	43	42	41	42	40	45	44	44	46
Nebraska	15	26	23	12	12	12	14	32	25	25	20
Nevada	6	48	48	47	45	44	34	48	47	45	35
New Hampshire	43	33	36	34	31	30	19	14	16	15	13
New Jersey	45	18	30	28	20	31	16	3	6	11	10
New Mexico	4	42	39	44	47	48	37	43	45	48	40
New York	28	1	5	2	1	2	1	5	1	2	1
North Carolina	27	16	8	23	25	25	33	21	30	29	33
North Dakota	16	40	35	36	32	32	26	40	37	35	27
Ohio	33	4	4	7	5	5	3	8	9	6	4
Oklahoma	36	45	42	45	46	46	47	42	42	43	47
Oregon	9	38	34	32	33	34	18	39	38	37	23
Pennsylvania	31	2	15	5	3	3	7	6	8	5	7
Rhode Island	48	35	45	43	39	40	21	1	5	13	5
South Carolina	38	23	11	35	34	33	45	17	33	31	45
South Dakota	14	37	29	24	21	24	17	37	34	32	21
Tennessee	32	13	10	15	16	16	30	13	20	18	28
Texas	1	7	2	4	14	13	28	33	31	34	34
Utah	11	39	40	39	40	39	27	41	41	40	30
Vermont	42	36	32	22	17	15	5	19	4	1	3
Virginia	34	15	17	21	19	18	25	15	23	24	22
Washington	18	34	37	38	35	36	23	36	39	36	24
West Virginia	40	28	25	25	22	23	31	24	21	22	25
Wisconsin	23	14	21	8	6	6	2	23	13	12	2
Wyoming	8	46	46	46	44	45	38	46	46	46	39

NOTE.—The above table is based on data in Tables II, VII, IX, and X. The first three columns show the rank of each State and Territory in size, total population, and agricultural population. The next two columns show their rank in the total number of cows and total milk production. It will be seen that in almost every case where dairying is extensively practiced a State ranks higher in total milk production than number of cows, showing the superior class of stock. The sixth and seventh columns show the rank in the total production of butter and cheese. The last four columns show intensity, and are more interesting in some respects than any of the others. One's opinion of the condition of dairying in any State is often formed by the total production, which depends largely on the size of the State. But some of the small States may have a much higher development of their dairy industry and produce more per square mile than large ones that produce a large total, as is shown in Table X. The ranks of the States and Territories in regard to production per square mile are given in the last two columns.

TABLE XII.—*Neat cattle on ranges in the United States.*

[Census of 1890.]

	Cattle.		Cattle.
Arizona	659,758	New Mexico	1,054,022
California	241,300	South Dakota	20,033
Colorado	448,681	Texas	2,342,083
Indian Territory	433,580	Wyoming	248,097
Montana	750,619		
Nevada	78,047	Total United States	6,285,220

TABLE XIII.—*Average value of a cow in the United States for the years stated.*

[U. S. Census and Department of Agriculture.]

Years.	Amount.	Years.	Amount.
1850	$20.02	1891	$21.62
1860	30.82	1892	21.40
1870	39.11	1893	21.75
1880	23.27	1894	23.18
1885	29.69	1895	21.96
1890	22.13		

TABLE XIV.—*Registered or pedigreed cattle of selected breeds in the United States and their values (estimates furnished by the secretaries of the respective breeders' associations).*

[From Report for 1885, United States Department of Agriculture.]

Breed.	Registered.	Living.	Average.	Total.
Aberdeen Angus		3,500	$300	$1,050,000
Ayrshire	12,867	6,433	100	643,300
Devon	10,187	8,000	81	648,000
Guernsey	4,947	3,100	149	461,000
Hereford		14,000	300	4,200,000
Holstein-Friesian	21,138	20,081	200	4,016,200
Jersey	51,000	....	....	....

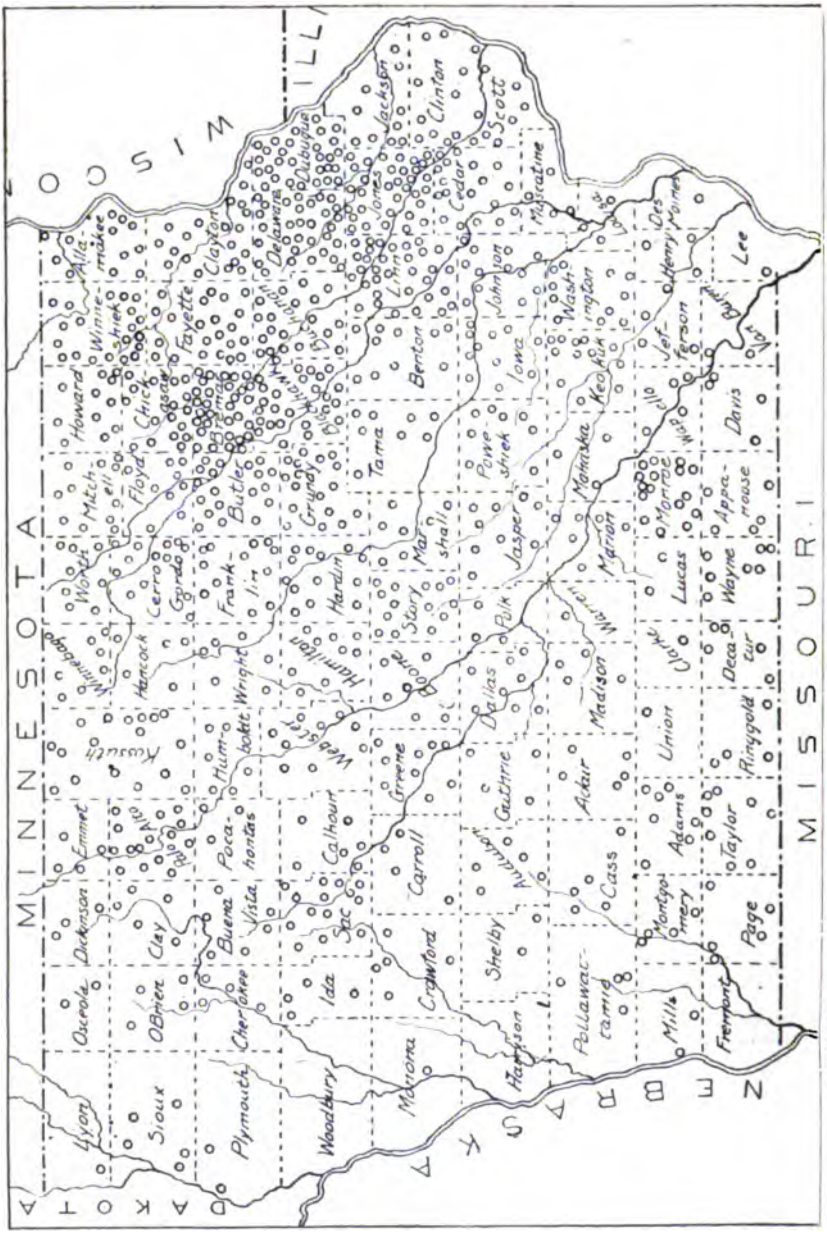
[For the year 1895, as reported to the Dairy Division.]

Breed.	Registered.	Living.	Average.	Total.
Ayrshire	18,750	9,375	$100	$937,500
Brown-Swiss	1,930	1,200	150	180,000
Devon	17,007	14,500	81	1,174,500
Dutch-Belted	971	720	200	144,000
Guernsey	12,547	8,500	165	1,402,500
Holstein-Friesian	90,325	70,000	100	7,000,000
Jersey	150,000	100,000	100	10,000,000
"Maine State" Jersey	3,927	2,800	55	154,000
Red Polled	4,408	3,000	80	240,000

TABLE XV.—*Growth of the factory system in the United States—States, years, and number of factories, from various sources.*

United States.		Connecticut.		Illinois.		Iowa.		Maine.		New York.		Ohio.		Vermont.		Wisconsin.	
Year.	No.	Year.	No.	Year.	No.	Year.	No.	Year.	No.	Year.	No.	Year.	No.	Year.	No.	Year.	No.
1850	8	1851	1	1862	1	1866	1	1869	1	1851	1	1850	2	1870	28	1841	1
1860	10	1870	7	1874	45	1870	14	1874	40	1861	3	1862	1	1874	32	1864	2
1861	56	1880	16	1875	200	1874	45	1880	41	1864	269	1874	108	1880	85	1865	30
1864	402	1890	50	1890	266	1888	468	1890	42	1865	484	1880	452	1890	124	1872	150
1870	1,313	......	....	1894	530	1894	870	1894	58	1874	1,018	1890	361	1894	250	1874	175

The first cheese factory and first creamery were started, respectively, in New York in 1861 and 1864; in Illinois, 1862 and 1870; in Iowa, 1866 and 1871.



OUTLINE MAP OF IOWA, SHOWING DISTRIBUTION OF CREAMERIES (RE-ENGRAVED FROM ANNUAL REPORT OF THE STATE DAIRY COMMISSIONER).

DAIRY STATISTICS RELATING TO SEVERAL STATES, LATER THAN 1890.

[Supplied by various State authorities.]

CALIFORNIA.

[From Louis Tomasini, manager Dairymen's Union of California.]

Cows in the State [1894], total, 333,310.

Used for butter, 207,444; for cheese, 19,200; for the milk trade, 106,666.

Dairy products of State, 1894 (estimated):

31,116,600 pounds butter, at 19 cents	$5,912,154
9,000,000 pounds cheese, at 9 cents	810,000
50,000,000 gallons milk, at 12 cents	6,000,000
Skim milk, etc., made into pork	1,037,220
Calves (333,310), at $2	666,620
Total value average yearly products	14,425,994

Other California yearly products for comparison: Wheat, $16,128,381; gold and silver, $14,000,000; fruits, $11,025,000; grapes and wines, $8,150,000; sheep, lambs, and wool, $7,588,850.

CONNECTICUT.

[From the annual report for 1895, of C. S. Burlingame, State dairy commissioner.]

62 creameries, located in 62 different towns.

Butter produced by same in one year, 4,230,156 pounds.

Average per factory, 68,228 pounds.

NOTE.—Several creameries sell milk and cream mainly, making very little butter.

INDIANA.

[From township assessors' returns, furnished by S. J. Thompson, chief Indiana Bureau of Statistics.]

Cattle and dairy products for April and May, 1895:

Jerseys, 49,136; Holsteins, 9,606; Shorthorns, 55,255; all other, 813,495.

Cattle died in past year, 27,011. Milch cows, 468,043.

Milk produced in year, 145,396,868 gallons; butter made in year, 35,200,916 pounds; cheese made in year, 394,645 pounds.

NOTE.—Figures rather below the facts, as some returns were omitted—for example, about 50 creameries and cheese factories.

ILLINOIS.

[Estimates of dairy products for 1893, made by the Illinois State Dairymen's Association, W. R. Hostetter, secretary, for the souvenir Illinois dairy exhibit, World's Columbian Exposition.]

Value of milk consumed	$21,024,000
Value of condensed milk and cream	1,022,000
Illinois milk sent to St. Louis, Mo	402,960
Butter and cheese sold on the Elgin Board of Trade	8,315,286
Creamery butter and cheese sold outside the Elgin district	6,927,519
Dairy, or farm-made butter	31,000,000
Skim milk, etc., fed to stock, value	7,000,000
Total value—annual products	75,691,765

IOWA.

[From the annual report for 1895 of W. K. Boardman, State dairy commissioner.]

Creameries, etc.—Of the 99 counties in the State 95 have creameries or cheese factories; 2 counties have only cheese factories. (See map of Iowa upon the opposite page.) Of the 855 establishments reported, 64 were cheese factories, 20 made both butter and cheese, and the rest only butter; 282 were cooperative concerns, 132 were owned by stock companies, 438 were proprietary, and of 52 the organization or ownership was uncertain; 546 of these creameries use separators, 131 are operated upon the cream-gathering plan, and 106 combine the two systems; 716 receive milk, 456 pay for it on basis of fat tests, and 197 by weight; 525 creameries average 103 patrons each; there are 80,000 creamery patrons in the State; 516 creameries average 854 cows each, and the whole number of cows contributing to Iowa creameries is about 676,000. The total output of the factories for the year is estimated at $13,300,000 in value, an average of $15,555 per factory.

Shipments of butter from Iowa by rail: 1890, 71,255,796 pounds; 1891, 68,690,716 pounds; 1892, 60,112,931 pounds; 1893, 54,572,902 pounds; 1894, 52,649,284 pounds.

Estimated home consumption, 20,000,000 pounds for 1894.

Milk.—Eleven cities in the State, having a combined population of 350,073, have 383 wagons and stores which supply the milk from 7,316 cows, to 32,211 families, and 460 hotels and boarding houses. This milk is valued at $626,460, or $85.63 per cow. Three thousand nine hundred and thirty-five tests of milk in 1893 gave average of 3.59 per cent of fat; 3,984 such tests in 1894 gave average of 3.79 per cent of fat.

MAINE.

[The secretary of the State board of agriculture, B. Walker McKeen, furnishes returns to that board, and figures from State assessors' returns. All for the year 1894.]

Number of farms		65,400
Number of milch cows		141,262
Value of cows		$35,314,000
Number of creameries and cheese factories		58
Butter made in creameries, etc	pounds	2,513,090
Cheese made in factories	do	500,000

(The returns were regarded as incomplete.)

MICHIGAN.

[From the State census, June 1, 1894, Washington Gardner, secretary of state.]

Milch cows		506,390
Milk produced on farms	gallons	212,070,373
Value milk and cream sold from farms		$2,970,385
Butter made on farms	pounds	49,951,378
Cheese made on farms	do	206,660
Value butter and cheese made in factories		$1,708,431
Creameries, cheese factories, etc	number	222
Capital invested		$810,745
Employees, average number		619
Average wages:		
Skilled laborers		$1.95
Unskilled laborers		$1.04
Total wages paid		$195,564
Number of months in operation, average		7½
Materials used, value		$1,310,870
Products, total value		1,708,431

(One to six factories not reporting on some items, but do not materially affect these results.)

Cattle in Michigan, 1894:	
Cows	506,390
Working oxen	11,267
Others, all ages	554,583
Total	1,072,240

Others, by ages:	
Under 1 year	242,220
1 year and under 2	198,548
2 years and under 3	89,821
3 years and over	23,994
Pure-bred cattle, by breeds:	
Angus	67
Ayrshire	37
Brown-Swiss	3
Devon	48
Galloway	553
Guernsey	83
Hereford	444
Holstein	1,714
Jersey	3,855
Red-Polled	131
Shorthorn	4,059

MINNESOTA.

[From E. J. Graham, assistant State food and dairy commissioner, and P. D. Wildt, commissioner of statistics.]

Creameries, 1893:	
Total number establishments	253
On separator plan	147
Subsidiary skim stations	53
On cream-gathering plan	87
On mixed methods	16
Cooperative creameries	150
Proprietary	72
Owned by stock companies	31
Estimated products, 1893:	
Creamery butter, 23,000,000 pounds, at 21 cents	$4,830,000
Farm dairy butter, 7,000,000 pounds, at 15 cents	1,050,000
Farm dairy butter, 7,000,000 pounds, at 10 cents	700,000
Factory cheese, 2,000,000 pounds, at 9 cents	180,000
Estimated products, 1895:	
Creamery butter, 27,000,000 pounds, at 20 cents	5,400,000
Value of farm dairy butter	2,000,000

NOTES.—Thirty thousand farmers are patrons of creameries; 306 separators are used, of 17 styles and from 5 makers; 92 creameries built in 1892-93 are all on the separator plan and are cooperative concerns. Within the last year reported the proportion of creameries using the separator process has increased from 45 per cent to 60 per cent of the whole, and those operated on the cooperative plan from 42 to 60 per cent. Cheese factories decreased in number from 129 to 65.

Year.	Cows.	Butter.	Cheese.
		Pounds.	*Pounds.*
1871	106,016	7,356,768	469,147
1873	155,454	10,140,316	1,031,510
1875	176,278	12,029,371	1,009,999
1877	200,379	13,443,195	829,075
1879	225,516	15,639,069	586,448
1881	221,213	16,052,020	522,456
1883	288,896	20,525,357	615,497
1885	339,933	24,495,074	850,843
1887	392,027	28,117,172	1,074,251
1889	412,036	29,165,137	1,274,076
1891	424,881	27,203,945	1,374,555
1892	411,349	28,041,476	868,567
1893	....	35,864,832	1,675,525

Population of Minnesota: 1870—439,706; 1875—597,407; 1880—780,733; 1885—1,117,798; 1890—1,301,826.

NEBRASKA.

[From S. C. Bassett, secretary State Dairy Association.]

Estimates for 1894:

Number of cows		563,313
Value of cows		$12,502,886
Creameries, etc	number	97
Butter made in creameries	pounds	7,072,593
Butter made on farms	do	30,669,378
Cheese made in factories	do	885,079
Cheese made on farms	do	510,214
Milk, total product	gallons	159,245,089
Farm value of total milk		$11,943,381

NEW YORK.

[From report for 1894, of the State commissioner of agriculture, Fred. C. Schraub.]

New York has 60 counties; butter and cheese factories are operated in 48 of them.

Creameries or butter factories		225
Cheese factories		1,156
Combined butter and cheese		213
Dairy manufacturing establishments		1,624
Products, 1894:		
Butter made at creameries, etc	pounds	23,218,626
Cheese made at factories, etc	do	115,760,325

NORTH DAKOTA.

[From reports of State assessors for 1894, compiled by department of agriculture and labor, A. H. Laughlin, commissioner.]

Milch cows, 2 years old and over		114,985
Value of cows		$1,389,832
Creameries, cheese factories, etc		24
Butter and cheese made in same not given.		
Butter made on farms	pounds	4,428,157
Cheese made on farms	do	100,891
Milk sold from farms	do	791,306

OHIO.

[From the office of the secretary of state, furnished by F. B. McNeal, dairy and food commissioner.]

Milch cows (1893)		583,071
Butter made on farms	pounds	49,737,682
Butter made in creameries	do	4,177,414
Cheese made on farms	do	892,089
Cheese made in factories	do	13,824,696
Milk sold from farms, excluding that sent to creameries, etc	gallons	22,095,825

YEARLY DAIRY PRODUCTS.

[From the Ohio Farmer, 1872.]

Year.	Butter.	Cheese.	Year.	Butter.	Cheese.
	Pounds.	*Pounds.*		*Pounds.*	*Pounds.*
1861	35,442,858	20,637,253	1865	32,450,139	16,947,905
1862	34,065,629	20,752,097	1866	36,344,608	22,198,929
1863	31,121,275	19,130,750	1867	34,833,445	19,985,486
1864	31,141,876	18,097,095	1868	37,005,378	17,814,599

VERMONT.

[From George W. Pierce, secretary Vermont Dairymen's Association.]

Estimates for 1893-94:

Milch cows		225,000
Value of same		$5,625,000
Creameries and cheese factories		250
Butter made on farms	pounds	18,000,000
Butter made in creameries	do	13,000,000
Cheese made on farms	do	1,000,000
Cheese made in factories	do	2,000,000

(Partially based upon returns.)

WASHINGTON.

[From correspondent in Chicago Produce.]

Estimates for 1895:

Creameries and cheese factories		52
Daily output of same—		
Butter	pounds	7,000
Cheese	do	2,400
Annual products of the State—		
Butter	pounds	2,190,000
Cheese	do	547,000
Consumption—		
Butter	pounds	2,920,000
Cheese	do	730,000

NOTE.—In 1891 the State produced only 5 per cent of the butter and cheese there consumed.

WISCONSIN.

[From the State census of 1895, furnished by H. C. Adams, dairy and food commissioner.]

Farms		150,801
Milch cows		842,039
Value of cows		$17,442,144
Creameries		753
Cheese factories		1,337
Butter made on farms and in creameries	pounds	74,653,730
Cheese made on farms and in factories	do	52,480,815
Milk produced on farms, estimated	gallons	315,000,000
Value of annual dairy products, estimated		$30,000,000

BULLETIN NO. 12.

U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF ANIMAL INDUSTRY.

TAPEWORMS OF POULTRY.

REPORT UPON THE PRESENT KNOWLEDGE OF THE TAPEWORMS OF POULTRY. WITH 276 FIGURES ON 21 PLATES.

By CH. WARDELL STILES, A. M., PH. D.

BIBLIOGRAPHY OF THE TAPEWORMS OF POULTRY.

By ALBERT HASSALL, M. R. C. V. S.

Prepared under the direction of

Dr. D. E. SALMON,

CHIEF OF THE BUREAU OF ANIMAL INDUSTRY.

Issued July 11 1896.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1896.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Animal Industry,
Washington, D. C., December 21, 1895.

Sir: I have the honor to transmit herewith for publication a "Report upon the Present Knowledge of the Tapeworms of Poultry," by Dr. C. W. Stiles, to which is appended a "Bibliography of the Tapeworms of Poultry," by Albert Hassall, M. R. C. V. S. The subject is a very important one, both from practical and scientific points of view. Our knowledge of the parasites of poultry is in a very unsatisfactory condition, and the contributions to it are so scattered through the literature of the world that they are not available to the greater part of those engaged in the investigation of this and allied subjects. The work of Drs. Stiles and Hassall is well done, and will not only prove of immediate value to poultrymen but it must long stand as a foundation for other scientific investigations.

Very respectfully,

D. E. Salmon,
Chief of Bureau.

Hon. J. Sterling Morton,
Secretary of Agriculture.

LETTER OF SUBMITTAL.

U. S. Department of Agriculture,
Bureau of Animal Industry,
Zoological Laboratory,
Washington, D. C., December 17, 1895.

Sir: I have the honor to submit herewith for publication a "Report upon the Present Knowledge of the Tapeworms of Poultry," prepared by myself, and a "Bibliography of the Tapeworms of Poultry," prepared by Albert Hassall. The present report was suggested by requests for information coming from officers of experiment stations and others engaged in investigating the diseases of poultry. The drawings to be used in illustrating the report were made by Mr. William S. D. Haines.

Respectfully, yours,

Ch. Wardell Stiles,
Zoologist, Bureau of Animal Industry.

Dr. D. E. Salmon,
Chief, Bureau of Animal Industry.

CONTENTS.

Page.
REPORT UPON THE PRESENT KNOWLEDGE OF THE TAPEWORMS OF POULTRY. WITH 276 FIGURES ON 21 PLATES, BY CH. WARDELL STILES 9–79
Part I.—General discussion 9–21
Life history and source of infection 11–13
The relation of the tapeworms of wild birds to those of the domesticated fowls 13
Symptoms and pathology 13–17
Tapeworm-infected fowls as food 17
Prevention 17–18
Treatment 18–21
Part II.—Classification 22–79
Analytical key to families and genera 23–25
Family *Bothriocephalidæ* 25–27
Bothriocephalinæ 25–27
Bothriocephalus Rudolphi, 1808 25–26
1. Bertkau's pigeon *Bothriocephalus* sp.? 26
Bothriotænia Railliet, 1892 26–27
2. *Bothriotænia longicollis* (Molin, 1858) Railliet, 1892 26-27
Ligulinæ 27
Ligula Bloch, 1782 27
Family *Tæniidæ* 28–61
Tæniinæ 28
Anoplocephalinæ 28
Mesocestoidinæ 28
Mesocestoides Vaillant, 1863 28
Dipylidiinæ 28–61
Dipylidium R. Leuckart, 1863 29
Cotugnia Diamare, 1893 29–31
3. *Cotugnia digonopora* (Pasquale, 1890) Diamare, 1893 30
4. *Cotugnia bifaria* (von Siebold, 1848) Diamare, 1893 30–31
Amabilia Diamare, 1893 31
5. *Amabilia lamelligera* (Owen, 1835) Diamare, 1893 31
Hymenolepis Weinland, 1858 31–32
Dicranotænia Railliet, 1892 32–36
6. *Dicranotænia coronula* (Dujardin, 1845) Railliet, 1892 33
7. *Dicranotænia æquabilis* (Rudolphi, 1810) Railliet, 1893 33–34
8. *Dicranotænia furcigera* (Rudolphi, 1819) Stiles, 1896 34–35
9. *Dicranotænia sphenoides* (Railliet, 1892) Railliet, 1896 35–36
Drepanidotænia Railliet, 1892 36–45
10. *Drep. lanceolata* (Bloch, 1782) Railliet, 1892 36–37
11. *Drep. fasciata* ([?Rudolphi, 1810] Krabbe, 1869) Railliet, 1893 37–38
12. *Drep. gracilis* ([? Zeder, 1803] Krabbe, 1869) Railliet, 1893 38–39
13. *Drep. anatina* (Krabbe, 1869) Railliet, 1893 39–40

Part II.—Classification—Continued. Page.
Family *Tæniidæ*—Continued.
Drepanidotænia Railliet, 1892—Continued.
14. *Drep. sinuosa* (Zeder, 1800) Railliet, 1893 40–41
15. *Drep. setigera* (Frölich, 1789) Railliet, 1893 41–42
16. *Tænia Krabbei* Kowalewski, 1894 nec Moniez, 1879 42–43
17. *Drep. tenuirostris* (Rudolphi, 1819) Railliet, 1893 43
18. *Drep. infundibuliformis* (Gœze, 1782) Railliet, 1893 43–45
Davainea R. Blanchard & Railliet, 1891 45–55
19. *Dav. proglottina* (Davaine, 1860) R. Blanchard, 1891 47
20. *Dav. circumvallata* (Krabbe, 1869) R. Blanchard, 1891 47–48
21. *Dav. cesticillus* (Molin, 1858) R. Blanchard, 1891 48–49
22. *Dav. echinobothrida* (Mégnin, 1881) R. Blanchard, 1891 49
23. *Dav. tetragona* (Molin, 1858) R. Blanchard, 1891 49–52
24. *Dav. Friedbergeri* (Linstow, 1878) R. Blanchard, 1891 52–53
25. *Dav. crassula* (Rudolphi, 1819) Railliet, 1893 53–54
Echinocotyle R. Blanchard, 1891 55–56
26. *E. Rosseteri* R. Blanchard, 1891 55–56
Ophryocotyle Friis, 1869 56
Tænia s. l., gen. incert. 56–60
27. *T. cantaniana* Polonio, 1860 57
28. *T. Delafondi* Railliet, 1892 57
29. *T. exilis* Dujardin, 1845 58
30. *T. imbutiformis* Polonio, 1860 58
31. *T. megalops* Nitzsch, 1829 59
32. *T. nigropunctata* Crety, 1890 59
33. *T. sp.* Conard, MS 59–60
Fimbriaria Frölich, 1802 60
34. *Fimbriaria malleus* (Goeze, 1782) Frölich, 1802 60
Idiogenes Krabbe, 1868 60
Addendum 60
Explanation of chart 61
Chart of parasites arranged according to their hosts 61
Description of plates 62–73
Index to scientific names 75–79
BIBLIOGRAPHY OF THE TAPEWORMS OF POULTRY, BY ALBERT HASSALL 81–88

ILLUSTRATIONS.

Page.

Plate I.—*Cotugnia digonopora* 74

II.—*Cotugnia bifaria* and *Amabilia lamelligera* 74

III.—*Dicranotænia coronula*, *Dicranotænia æquabilis*, *Dicranotænia furcigera*, and *Tænia conica* 74

IV.—*Dicranotænia sphenoides* and *Drepanidotænia lanceolata* 74

V.—*Drepanidotænia lanceolata* and *Drepanidotænia fasciata* 74

VI.—*Drepanidotænia fasciata* 74

VII.—*Drepanidotænia fasciata* and *Drepanidotænia gracilis* 74

VIII.—*Drepanidotænia gracilis* 74

IX.—*Drepanidotænia anatina* 74

X.—*Drepanidotænia anatina* and *Drepanidotænia sinuosa* 74

XI.—*Drepanidotænia sinuosa* 74

XII.—*Drepanidotænia sinuosa*, *Drepanidotænia setigera*, and *Tænia Krabbei*, *Kowalewski nec Moniez* 74

XIII.—*Drepanidotænia sinuosa* and *Drepanidotænia setigera* 74

XIV.—*Drepanidotænia tenuirostris* and *Drepanidotænia infundibuliformis* 74

XV.—*Drepanidotænia infundibuliformis* and *Davainea proglottina* 74

XVI.—*Davainea proglottina* and *Davainea circumvallata* 74

XVII.—*Davainea cesticillus*, *Davainea echinobothrida*, and *Davainea tetragona*. 74

XVIII.—*Davainea tetragona*, *Davainea Friedbergeri*, and *Davainea crassula* 74

XIX.—*Echinocotyle Rosseteri* and *Ophryocotyle proteus* 74

XX.—*Tænia cantaniana*, *Tænia Delafondi*, *Tænia imbutiformis*, *Tænia megalops*, and *Tænia nigropunctata* 74

XXI.—*Tænia malleus*, *Idiogenes otidis*, and *Tænia* sp 74

TAPEWORMS OF POULTRY.

REPORT UPON THE PRESENT KNOWLEDGE OF THE TAPEWORMS OF POULTRY.

By CH. WARDELL STILES.

PART I.

GENERAL DISCUSSION.

It has been known for years that tapeworms infest domesticated poultry, and that in some cases they cause serious epizootics among fowls. The outbreaks thus far recorded have occurred chiefly in Europe, and as a natural outcome almost the entire work which has been published on these parasites is the result of European investigations. The literature upon the subject is accordingly in Latin, German, French, Danish, Italian, etc., while in the English language we have only a few short notices concerning these worms. Generic and specific diagnoses of the parasites of this group are almost unknown articles in the English language, while as yet we have absolutely no reliable data as to how many species of tapeworms are found in American poultry.

Several outbreaks of tapeworm disease have been noticed in fowls in different parts of the country, and upon various occasions specimens have been sent to this Bureau for identification. As Dr. Moore (1895)[1] has recently called attention to this disease, and as we shall probably hear of its existence in various parts of the country, it may be well to state at this time what is known regarding the tapeworms of domesticated fowls and, in response to several requests from experiment stations, to give the generic and specific diagnoses as they at present stand.

The following table shows 33 species which have been recorded for poultry, but several of these are doubtful, and probably several forms appear in the list more than once, under different names. Besides the forms given, one or two other forms have been recorded, but can be ignored for the present. A square □ signifies that the parasite is recorded only from poultry; a cross × that it occurs in wild birds, but probably not in poultry; the double cross ⊞ signifies that the parasite is recorded both in poultry and in wild birds.

---

[1] The dates in parentheses refer to the articles cited in the bibliography, p. 81–88.

Table of tapeworms recorded for poultry.

Name of parasite.	Pigeon.	Turkey.	Guinea fowl.	Peacock.	Chicken.	Swan.	Goose.	Duck.	Ostrich.	Known or supposed source of infection.
BOTHRIOCEPHALIDÆ:										
BOTHRIOCEPHALUS—										
sp. ?	?									
BOTHRIOTÆNIA—										
longicollis					□					
LIGULA—										
sp. ?	×							×		Does not normally occur in these hosts, experimentally infected by feeding larvæ from fish.
TÆNIIDÆ:										
COTUGNIA—										
digonopora					□					
DICRANOTÆNIA—										
æquabilis						?				
coronula								⊞		Small fresh-water mussel crabs (*Cypris ovum*, *C. cinerea*, *Cypria ophthalmica*, *Candona candida*).
furcigera								?		See *T. trilineata*, p. 35.
sphenoides					□					Earthworms (*Allobophora fœtida*).
DREPANIDOTÆNIA—										
anatina								⊞		Small fresh-water mussel crabs (*Cypris ovata*, *C. incongruens*, *C. compressa*).
fasciata							⊞			Small fresh-water copepods (*Cyclops agilis*).
gracilis							⊞	⊞		Small fresh-water mussel crabs (*Candona rostrata*, *Cypria ophthalmica*) and copepods (*Cyclops viridis*).
infundibuliformis	?				⊞			⊞		House fly (*Musca domestica*).
lanceolata							⊞	⊞		
setigera						?	⊞			Small fresh-water copepods (*Cyclops brevicaudatus*).
sinuosa							⊞	⊞		Flea crabs (*Gammarus pulex*) and copepods (*Cyclops viridis*, *C. agilis*, *C. lucidulus*).
tenuirostris							⊞	?		Flea crabs (*Gammarus pulex*) and copepods (*Cyclops agilis*, *C. pulchellus*).
DAVAINEA—										
cesticillus					□					
crassula	⊞							?		
echinobothrida	?				□					
proglottina					□					Slugs (*Limax agrestis*, *L. variegatus*, *L. cinereus*).
struthionis									□	
tetragona					□					Probably snails (*Helix carthusianella ?* or *H. maculosa ?*).
ECHINOCOTYLE—										
Rosseteri								□		Small fresh-water mussel crabs (*Cypris cinerea*).
TÆNIA s. l.—										
cantaniana		□								
conica								?		See p. 35.
Delafondi	□									
exilis					□					
imbutiformis								?		
Krabbei							□	?		See p. 42.
malleus					⊞			⊞		
megalops								⊞		
sp. (Conard, MS.)					□					
sp		□								
	2(6)	2			11	(2)	7	9(16)	1	

From this table it will be noticed that 6 different tapeworms have been recorded from pigeons, 2 from turkeys, 11 from chickens, 2 from swans, 7 from geese, 16 from ducks, and 1 from ostriches; 1 form has been recorded as common to pigeons, chickens, and ducks; 5 forms as common to ducks and geese; 1 form as common to geese and swans; 1 as common to pigeons and ducks, and 1 as common to pigeons and chickens. These statistics are based upon the suppositions that all the parasites mentioned are good species, and that the specific determinations of the parasites were correct. A comparison of the original types would, however, undoubtedly show that both of these suppositions are incorrect, for many of the species are very poorly described, and have been established upon very limited material.

Many of the specific diagnoses existing to-day are almost worthless, some of the species rest upon very weak characters and must undoubtedly fall, while the synonymy and proper names of the group need thorough revision. It would be hazardous to make any radical changes in the system at present, in fact, I do not believe this should be done unless the worker has a large series of specimens, with types, if possible, before him.

LIFE HISTORY AND SOURCE OF INFECTION.

Fortunately the life history of a number of forms is known. So far as yet worked out, the larval stage is in every case a *cysticercoid* and lives in some invertebrate (snail, insect, crustacean, or worm). A glance at the above table and the remarks under each specific diagnosis will show the source of infection (intermediate hosts) so far as known or supposed. There are no grounds for believing that poultry can become infected with tapeworms directly from the eggs contained in the droppings.

The life history of these worms agrees with the life history of other tapeworms; the ova of the parasites are voided with the excrement and are swallowed by an intermediate host; the six-hooked embryo (known as an *oncosphere*) contained within the eggshell then bores its way from the intestine into the body cavity of the intermediate host (a worm, snail, crustacean, or insect) and develops into a larval form (known in this case as a *cysticercoid*). This larva develops into an adult worm when swallowed by a chicken, duck, goose, etc.

The known or supposed life history has been based upon four different methods of work, i. e.—

1. Experimental infection of the fowls by feeding to them known larval stages found in invertebrates, and thus raising the adult stage.
2. Experimental infection of invertebrates by feeding to them the eggs of tapeworms found in birds, and thus raising the larval stage.
3. Comparison of the hooks upon the heads of adult tapeworms of birds with the hooks of larvæ found in invertebrates, and thus associating the young and the old stages.
4. Wild speculation as to the intermediate hosts, based upon negative results and totally devoid of any scientific foundation.

Of these four methods of work the first two give positive proof of the life history when the experiments are successful; the third gives a probability to the statements, but not a proof; the less said about the fourth method the better.

The following are the data we have at present regarding the life history:

1. *Experimental infection of fowls with larvæ found in invertebrates.*

Davainea proglottina[1] of chickens.—Grassi & Rovelli (1888, 1889A, 1892) fed the

---

[1] There are as yet but few popular names for the various poultry tapeworms. Several new popular names are introduced in the second part of this paper, but for the sake of exactness and brevity it is necessary to introduce the scientific names in all cases.

eggs (Pl. XV, fig. 198) of this tapeworm (Pl. XV, fig. 194) to slugs (*Limax*), and raised the larval stage (Pl. XVI, figs. 199–202) in twenty days. Slugs containing these larvæ were then fed to chickens, and within eight days the four segments were formed. There can, therefore, be no question that chickens become infected with this tapeworm by eating slugs.

Echinocotyle Rosseteri of ducks.—Small fresh-water crustaceans (*Cypris cinerea*)[1] containing a very characteristic larval tapeworm (Pl. XIX, fig. 251) were fed to a domesticated duck by Rosseter (1891A-B, 1892). The duck was afterwards killed and found to be infested with tapeworms possessing the same characteristic head (Pl. XIX, figs. 247–248). The life history of this form must therefore be looked upon as experimentally demonstrated.

2. *Experimental infection of invertebrates by feeding the eggs of avian tapeworms:*

Davainea proglottina of chickens.—This case has been discussed above.

Drepanidotænia anatina of ducks.—Schmidt (1894) has recently demonstrated the life history of this worm in a manner which places the source of infection beyond question. He fed large quantities of tapeworm eggs to fresh-water crustaceans (*Cypris ovata*[1]) and thus raised the larval form (Pl. IX, fig. 110). In summer these larvæ developed in two weeks, but in winter they required over five weeks for their development, the difference in time being attributed to the difference in the temperature. The same larval form is described by Mrázek (1891) also from two other mussel crabs, i. e., *Cypris incongruens*[1] and *Cypris compressa*[1] (= *Cypria ophthalmica* according to Moniez).

3. *Comparison of the hooks upon the heads of the adult tapeworms in birds with the hooks of larvæ found in invertebrates, and thus associating the young and old stages.*

This method of explaining the life history does not furnish the data which are demanded in science of to-day, although it shows what the probable life history is.

Davainea tetragona of chickens.—Piana (1881, 1882) found two larvæ (Pl. XVIII, figs. 228–229) in snails of the genus *Helix*, which he associated with this chicken tapeworm (Pl. XVII, figs. 219–227, Pl. XVIII, figs. 231–235).

Dicranotænia coronula of ducks.—Mrázek (1890) found larvæ (Pl. III, fig. 25) in fresh-water mussel crabs (*Cypris ovum* and *Cypria ophthalmica* (*Cypris compressa*); Rosseter (1890) found a cysticercoid in *Cypris cinerea*, and Moniez (1891) in *Cypria ophthalmica* and *Candona candida*, which the three respective authors have associated with *D. coronula* of ducks.

Dicranotænia sphenoides of chickens.—Grassi & Rovelli (1889A, 1892) claim to have found cysticercoids (Pl. IV, fig. 40) in earthworms (*Allobophora fœtida*) which they associate with this species of tapeworm (Pl. IV, figs. 37–38).

Drepanidotænia fasciata of geese.—Mrázek (1890, 1891) classified a cysticercoid (Pl. VI, figs. 67–70) found in fresh-water crustaceans (Pl. VI, fig. 67) (*Cyclops agilis*) as the larva of this cestode (Pl. V, figs. 56–66).

Drepanidotænia gracilis of ducks and geese.—Cysticercoids (Pl. VIII, figs. 94–99) found in fresh-water mussel crabs (*Candona rostrata* by Scott, 1891, p. 314; *Cypris compressa* by Mrázek, 1891; *Cyclops viridis* by Mrázek, 1891, and *Cypria ophthalmica* by Moniez, 1891, p. 26) and in copepods (*Cyclops* sp.?) by Schmidt, 1894, are looked upon as the larval stage of this parasite (Pl. VII, 80–85).

---

[1] There are no popular names for the numerous different species of small fresh-water crustaceans. The popular name *mussel crabs* is used for the *Ostracoda* (*Cypris. Candona*, etc.); *water fleas* for *Daphnia*; *copepods* for the *Copepoda* (*Cyclops*, Pl. VI, fig. 67; Pl. XI, fig. 130); *flea crabs* for *Gammarus*.

Drepanidotænia infundibuliformis of chickens and ducks.—Grassi & Rovelli (1889A, p. 404; 1892) state that the larva (Pl. XV, fig. 191) of this parasite (Pl. XIV, figs. 173, 178) is found in the house fly.

Drepanidotænia setigera (Pl. XIII, fig. 154) of geese.—Infection attributed by von Linstow (1892B, p. 503), to a cysticercoid found by Schmeil in copepods (*Cyclops brevicaudatus*).

Drepanidotænia sinuosa (Pl. X, fig. 118) of ducks and geese.—Supposed to develop from cysticercoids (Pl. XI, figs. 130, 135) found in flea crabs (*Gammarus pulex*) by Hamann (1889, pp. 1–7; in copepods (*Cyclops viridis*, *C. agilis*, and *C. lucidulus*) by Mrázek.

Drepanidotænia tenuirostris of geese.—Supposed larval stage (Pl. XIV, figs. 165, 168) was found in flea crabs (*Gammarus pulex*) by Hamann (1889, pp. 7–9) and von Linstow (1892A, p. 338); and in copepods (*Cyclops agilis* and *C. pulchellus* by Mrázek 1891).

Thus, chickens are *known* to become infected with one tapeworm through eating slugs (*Limax*). They are *supposed* to become infected with a second through eating snails (*Helix*); by a third through eating flies, and by a fourth through eating earthworms.

Ducks are *known* to become infected with two worms through swallowing fresh-water crustaceans, and are *supposed* to become infected with three other tapeworms in the same way; another tapeworm is *supposed* to be transmitted to them through flies.

Geese are *supposed* to become infected with five species of tapeworms by swallowing small fresh-water crustaceans.

Nothing is known in regard to the source of infection of the tapeworms of pigeons and turkeys, but investigations in this field should be based upon the tapeworms of chickens.

THE RELATION OF THE TAPEWORMS OF WILD BIRDS TO THOSE OF THE DOMESTICATED FOWLS.

Only two of the chicken tapeworms (*Dr. infundibuliformis* and *T. malleus*) have as yet been recorded for wild birds, but the majority of the tapeworms found in the domesticated ducks and geese are also recorded from closely allied wild birds; besides these forms, however, many species have been described in wild birds which are not known to occur in the domesticated fowls. (See chart at end of text.) This renders the economic side of the question of avian cestodes extremely complicated and demands a thorough study of the parasites of wild birds in connection with those of our domesticated fowls.

SYMPTOMS AND PATHOLOGY.

From a standpoint of symptomatology, practically nothing is known upon this subject. In general, however, it may be stated that aquatic birds are less affected by the presence of tapeworms than land birds; that young birds suffer more than old birds; and that, although a fowl may harbor a small number of tapeworms without showing any appreciable effects, a heavy infection injures the health and may result in death, as has been abundantly demonstrated by epidemics observed in different parts of the world. It has also been noticed that poultry are more severely infested in wet years than in dry years, and the general application may be made that poultry kept in damp places will be more heavily infested than fowls kept in dry places. All of these statements are general principles of parasitology.

Zürn (1882, p. 17) gives the symptoms as follows:

> If numerous tapeworms are present in the intestine of young or old fowls a more or less extensive intestinal catarrh develops, corresponding to the greater or less number of parasites present.
>
> The intestinal catarrh shows itself, especially in chickens and geese, as follows: The sick animals become emaciated, although the appetite is not especially disturbed. At times the appetite is even increased. The droppings are thin, contain considerable yellow slime, and are passed in small quantities but at short intervals. The poultry raiser must direct his attention to these thin, slimy, and often bloody droppings, for if any treatment against the tapeworms is to be undertaken, this must be done as early as possible. In observing the droppings it should be noticed whether tapeworm segments or eggs are present. The eggs can be seen, of course, only with the microscope.
>
> After a time other symptoms develop. The sick animals become dull and listless, remain apart from the rest of the flock—the feathers are ruffled and the wings drop, the appetite is lost and the birds allow themselves to be easily caught. Although it was stated that in the beginning of the trouble the appetite is not disturbed, the sick animals develop an intense thirst for cold water. When it rains they run under the eaves in order to catch water, and in winter are eager for ice water.
>
> At reading this some experienced poultry raisers will probably reply that many chickens which are not sick are fond of very cold water. The droppings are also thicker or thinner according to the food. Both of these facts are known to me (Zürn). At the same time I look with suspicion of tapeworms upon every chicken which shows an especial thirst for cold water; and as for the droppings, the fowls infected with tapeworms have droppings mixed with mucus and blood, and pass their excrements much oftener than other fowls do.
>
> The intestinal catarrh often ends fatally.
>
> Upon post-mortem the body is seen to be thin and anæmic. The intestine generally contains no food, the mucosa is soft and hyperæmic and covered with reddish yellow, more or less thick, purulent mucus. According to Hertwig epileptic attacks are frequently noticed in chickens affected with intestinal worms.

The diagnosis by symptoms seems to me very uncertain, and although the symptoms described by Zürn serve as an indication of the disease, they can not be taken as proof. The diagnosis by hunting in the droppings for segments of the parasite is less satisfactory than would be supposed, for it is not rare to find chickens badly infested with tapeworms when it has been impossible to discover segments in the manure. This method is rendered doubly uncertain because the color of the segments is about the same as the urine in the fæces. Microscopic examination of the fæces for eggs is quite a certain though not positive method for diagnosis of tapeworm disease of poultry, but it is thoroughly impracticable for the farmer to attempt it. The best method for the farmer to follow is to kill one of the sick chickens, when he suspects tapeworms, and to cut out the intestine; he should then open the intestinal tract from the gizzard to the anus, in a bowl of warm water, and look for the parasites.

At least one species of tapeworm (*Davainea tetragona*) causes a serious nodular disease in the intestine of chickens which upon superficial examination may easily be mistaken for tuberculosis. This disease was probably first published by Rivolta & Del Prato (1880 or 1881?). It was afterwards described by Piana (1882) as occurring in chickens in Italy, and quite recently Moore (1895) has recorded it in this country. The following is extracted from Moore's article on the subject:

> In the spring of 1894, a fowl (*Gallus domesticus*) died at the experiment station of this Bureau with a disease characterized by nodules or tubercle-like bodies in the intestinal wall. Upon closer inspection the lesions were found to be in the subserous and muscular coats, and not, to any appreciable extent at least, in the glands. In the intestinal contents there was a large number of small tapeworms, many of which were firmly attached to the mucosa. Later in the season about twenty fowls from the same flock were used for experimental purposes, and upon post-mortem examination were found to be more or less affected with this disease. In addition to these, one of four fowls which were examined from a flock of poultry on a farm adjoining the experiment station was found to be infested with tapeworms and the intestinal wall studded with nodules. A fowl received from Newbern, N. C., and one from Tacketts Mills, Va., were similarly affected.
>
> Although but one fatal case came under my observation, the extent of the lesions in several of the fowls examined indicated that sooner or later many of them would undoubtedly have succumbed to this disease. The close resemblance of the nodules to tubercles renders necessary a somewhat detailed description of the lesions and of the means by which this disease can be readily differentiated from tuberculosis without the aid of laboratory facilities.
>
> *Description of the disease.*—The fowl which died apparently from this disease was much emaciated, and the lesions were restricted to the intestinal wall. In the fowls used for other purposes, there were no observable symptoms by which the nodular affection could be detected prior to post-mortem examination. Diphtheria was the immediate cause of death of the fowls from North Carolina and Virginia. All of the fowls examined, affected with this disease, were from one to three years old.
>
> The nodules were invariably more numerous in the lowest third of the small intestine. They occasionally appeared, however, in small numbers in both the duodenum and colon. The larger and to all appearances older nodules were found in the ileum near the cæca.
>
> In the badly affected portion the nodules gave the appearance of closely set protuberances, varying in size from barely perceptible areas of elevation to bodies 4^{mm} ($\frac{1}{6}$ inch) in diameter. In some instances they appeared to overlap one another. When separated by a band of normal tissue they were round or somewhat lenticular in form. In the latter case the long diameter was usually transverse to the long axis of the intestine. The larger nodules were of a pale or dark yellowish color while the smaller ones varied in shade from the more highly colored areas to the neutral gray of the normal serosa. To the touch they gave the sensation that would be expected if the subserous and muscular coats were closely studded with small, oval, solid bodies. The mucosa presented similar elevations. Attached to the mucosa over the nodules were a number of tapeworms. There were also in the more advanced cases a variable number of small (0.5 to 1^{mm}) areas over the larger nodules in which the mucosa had sloughed, leaving small ulcerated depressions.
>
> The larger nodules contained a greenish yellow, necrotic substance which appeared in the advanced stages as a sequestrum with a roughened surface. On section it has a glistening, homogenous appearance. Surrounding the necrotic substance was a thin layer of infiltrated tissue. The smaller nodules contained a more purulent-like substance and the smallest appeared to the naked eye as areas of infiltration. Sections of the affected intestine showed upon microscopic examination that the

heads of the tapeworms had penetrated the mucous membrane and were situated in different layers of the intestinal wall. They were frequently observed between the villi. As would be expected the heads were not readily detected in the necrotic masses contained in the larger nodules, but were almost invariably seen in the smaller ones. In a few sections the tapeworm could be traced through the mucosa to the nodule in the muscular tissue in which its head appeared. In the earlier stage of the nodular development there is a cell infiltration about the head of the worm. This process continues until the infiltrated tissue reaches a considerable size.

The worms attached to the mucosa were usually small. A larger form was commonly found in the intestinal contents. Although macroscopically they appeared to be different, Dr. Stiles found that they were presumably of the same species.

It appears from the literature that this disease has not heretofore been demonstrated in America. In 1881, Piana, described a disease of fowls in Italy, due to the presence of *Tænia bothrioplitis*. His article, however, deals more with the anatomy and classification of the infesting cestode than with the character of the lesions it produced. As he illustrates the nodules and heads of tapeworms in the intestinal wall there can be no doubt of the similarity of the lesions to those in the disease here described. Although fowls and birds are not infrequently infested with tapeworms, the lesions produced by these parasites are, with the exception indicated above, said to be more or less catarrhal in nature.

* * * * * * *

Economic importance.—The importance of this disease is much greater than it at first appears, as the close resemblance of the nodules to those of tuberculosis renders it of much significance from a differential standpoint. As the intestines are stated to be frequently the seat of the specific lesions of tuberculosis in fowls, it is of the greatest importance that a thorough examination be made before a positive diagnosis is pronounced. There are already several statements concerning the presence of tuberculosis in fowls in which the data given are not sufficient to differentiate the disease from the one here described. A somewhat analagous disease of sheep[1] caused by a nematoid (*Œsophagostoma columbianum* Curtice) has led to the deliberate destruction of many animals, the owners believing that tuberculosis was being eliminated from their flocks. As the inquiry into the cause of poultry diseases becomes more general, it is probable that this affection will be occasionally encountered, and unless its nature is recognized it may in some instances, like the sheep disease, lead to an unwarranted destruction of property.

In addition to its importance in differentiating tuberculosis it is in itself a malady worthy of careful attention. The fact that it has already appeared in two flocks in the District of Columbia and also in the States of North Carolina and Virginia, shows that the infesting cestode is quite widely distributed in this country. It is highly probable that the total loss it occasions both from deaths and from the shrinkage of poultry products, due to the chronic course of the disease it produces, is very large. * * *

Diagnosis.—Tuberculosis is, as before stated, the only known disease for which this affection is liable to be mistaken, and it is of much importance that the two diseases should not be confounded. The diagnosis has not in my experience been difficult, as in every case the attached tapeworms were readily detected upon a close examination of the intestinal contents, or of the mucous membrane of the infected portion of the intestine. However, the worms are quite small and could easily be overlooked in a hurried or cursory examination. In case of doubt, if the affected intestine is opened and the mucous surface washed carefully in a gentle stream of water, the small worms will be observed hanging to the mucous membrane. This discovery, in the absence of lesions in the liver or other organs, would warrant the diagnosis of the tapeworm disease. Although much is written concerning tuberculosis in fowls, especially in Europe, the investigations of poultry diseases by this Bureau have thus far shown that it is not common among fowls in this country.

---

[1] Animal parasites of sheep, Bureau of Animal Industry, Department of Agriculture, 1890, p. 165.

TAPEWORM-INFECTED FOWLS AS FOOD.

None of the tapeworms of birds are transmissible to man in any stage of their development, and the presence of tapeworms in the intestine of fowls does not in itself warrant the condemnation of their bodies as an article of food.

PREVENTION.

From the nature of the intermediate hosts (fresh-water crustaceans) of the tapeworms of aquatic birds it is evident that nothing can be done to prevent the introduction of larval tapeworms into ducks and geese, if these animals are allowed to visit ponds. Confining the animals to frequently flushed artificial tanks will, however, prevent tapeworm infection.

With chickens, the outlook is somewhat better. An extermination of slugs will insure immunity against *Davainea proglottina*, but no precise directions can be given to prevent chickens from becoming infected with other tapeworms until the life history of these parasites is better understood. It will be well, however, to keep chickens housed in the morning until the sun is well up and the ground is dry, for they will thus be less likely to meet with the supposable intermediate hosts of other worms.

Absolutely nothing can be done at present looking to a prevention of the transmission of tapeworms of wild birds to the domesticated fowls through known or unknown intermediate hosts, except to prevent the domesticated ducks, geese, etc., from visiting ponds.

There is, however, considerable outlook for improvement if different kinds of fowls are alternated in succeeding years upon the same ground, or if the runs and yards of fowls are occasionally changed. From the table (p. 10) it will be seen that thus far none of the tapeworms of chickens are known to occur in turkeys. Whether this immunity of chickens to turkey worms and turkeys to chicken worms is real or apparent, however, is yet to be scientifically determined. Should it prove to be real, then an alternation of flocks of turkeys and chickens in different years will probably insure practical immunity of both birds from any serious outbreaks of tapeworm disease. If, however, turkeys, or chickens, as the case may be, are raised upon the same grounds year after year, it is only natural that those grounds should become thoroughly infested with the larval stages of tapeworms and that fresh outbreaks of tapeworm disease should appear from time to time.

Alternating flocks of geese and ducks promise similar but less satisfactory results.

The safest plan to prevent the spread of poultry worms would be to destroy the manure from infected fowls. If one is not willing to do this, however, because of its commercial value, he should at least take steps to prevent further infection from it. If the sick chickens are confined to a comparatively small space their droppings can easily be collected and placed in a strong barrel, to which the access of snails, slugs, worms, etc., should be guarded against. It is not known how long the eggs of poultry tapeworms will live, but it seems very doubtful to me whether they could live many months in such a barrel if placed in a dry spot. It seems almost certain that they could not live through the winter. The temperature required to kill the eggs has likewise not yet been determined, but probably 50° C. to 60° C. (122° F. to 140° F.) would suffice. Sulphuric acid (10 per cent) or quick lime is an excellent disinfectant for fæces containing eggs of parasites.

The proper care of the manure from infected fowls is unquestionably the most important preventive measure against tapeworm disease.

TREATMENT.

The treatment of tapeworm disease in the domesticated fowls must for the present be more or less experimental, as the records in this line are extremely limited.

The first rule to be carried out in all cases of diseased animals, whether chickens, turkeys, geese, ducks, or others, is to isolate them from the rest of the flock and keep them confined until they have recovered. The second rule is to destroy the droppings of all animals known to be infected with parasites, or if the manure is needed as fertilizer, it should be treated in such a manner so as to kill the ova. These two rules can be easily carried out, and if a poultry raiser or a stock raiser is not willing to set aside a small yard for the isolation of the sick animals, where their droppings can be easily collected and taken care of every day, it is almost useless for him to administer anthelmintics to his fowls or other animals.

The chief drugs used against tapeworms are: Extract of male fern, turpentine, powdered kamala, areca nut, pomegranate root bark, pumpkin seeds, and sulphate of copper (bluestone).

Areca nut.—According to Zürn, powdered areca nut is the best tapeworm remedy for fowls, but he calls attention to the fact that turkeys are unfavorably affected by this medicine.

Zürn advises the administration of powdered areca nut in doses of 2 to 3 grams (=30 to 45 grains), mixed with butter and made into pills.

Liquid extract of male fern is very effectual against tapeworms. Hutcheon advises a teaspoonful for young ostriches three to four months old, to a tablespoonful for a full-grown ostrich; it may be made into a pill with flour.

Turpentine may be given to ostriches in doses of a desertspoonful for chicks three to four months old, to two tablespoonsful for a full-grown bird; its action is much more effective when combined with a purgative, such as linseed or castor oil. (Hutcheon.)

The Bureau has recently made the following experiments upon chickens to determine in what doses turpentine may be administered to them without danger. As in the experiments with bluestone cited below, a small rubber tube was inserted through the mouth to the crop, and the medicine forced through the tube with a large bulb pipette. This insured the deposit of the entire dose into the crop, and proved to be a most excellent method of administering the liquid, since it caused no pain to the animal, a chicken's gullet being quite large and easily admitting a $\frac{3}{16}$-inch (outside measurement) rubber tube.

No. 121. Full-grown chicken.

Jan. 13, dosed with 5^{cc} turpentine. Effects: Slight diarrhœa.

Jan. 16, dosed with 15^{cc} turpentine. Effects: Severe diarrhœa; animal sick and listless; complete recovery in three days.

No. 122. One-year-old chicken.

Jan. 13, dosed with 10^{cc} turpentine. Effects: Moderate diarrhœa.

Jan. 16, dosed with 25^{cc} turpentine. Effects: Very severe diarrhœa; animal quite sick and refused food; complete recovery in six days.

No. 123. Full-grown chicken.

Jan. 14, dosed with 15^{cc} turpentine. Effects: Moderate diarrhœa.

Jan. 16, dosed with 30^{cc} turpentine. Effects: Very severe diarrhœa; animal very sick and refused food; complete recovery in six days.

After performing these preliminary experiments in the laboratory I requested Dr. Schroeder to treat a larger number of fowls at the Experiment Station with doses of 15^{cc} turpentine, noting the age, sex, weight, etc., of the animals. Of these experiments he has handed me the following notes:

Each chicken in the following table received a dose of one-half ounce (14.785^{cc}) of spirits of turpentine injected through a rubber tube directly into the crop. The experiments took place from February 19 to February 25, 1896.

Number and sex.	Variety.	Weight.		Approximate age.		Remarks. [♂ = roosters, ♀ = hens.]
		Lbs.	Oz.	Years	Months	
125. ♀	Black mongrel	4	3	2-3	....	Two to three hours after the drug was given the chickens acted depressed and uneasy. Later they showed great drowsiness, were extremely thirsty, and passed large quantities of fluid, but very little solid fæces. In a few cases the respiration was labored. All the animals, with the exception of No. 151, made a good recovery in from 48 to 60 hours.
126. ♀	do	3	10	3	....	
127. ♀	do	3	7	1	6	
128. ♀	do	2	7.5	1	6	
129. ♀	do	2	3.5	1	....	
130. ♂	Black and white mongrel.	4	5	1	....	
131. ♂	do	3	9.5	1	....	
132. ♂	do	2	10.5	1	....	
133. ♂	White mongrel	2	......	......	6-8	
134. ♀	Buff mongrel	2	9.5	3	....	
135. ♂	Plymouth Rock	6	7.5	3	....	As far as it is possible to determine any difference in the action of turpentine on the different chickens from the small number included in the experiment, it seems as if the Black Spanish suffered more severely than the other varieties. No difference was noticed between the hens and roosters, but the younger and lighter-weight animals responded more than the older and heavier chickens.
136. ♀	do	5	2	4	....	
137. ♂	do	5	......	1	6	
138. ♀	do	4	9.5	3	....	
139. ♀	do	4	9.5	3	....	
140. ♀	do	3	13.5	3	....	
141. ♂	do	2	10.5	......	9	
142. ♀	do	2	10.5	4	....	
143. ♂	Leghorn	4	6	2	....	
144. ♀	Brown Leghorn	3	6.5	2-3	....	
145. ♀	do	2	12	3	....	
146. ♀	Buff Leghorn	4	10	3	....	Chicken No. 151 died about twenty-eight hours after being dosed. Post-mortem: Intestine almost throughout its entire length congested in form of fine points; liver engorged with blood; heart, muscle pale, ventricles empty; kidneys apparently normal; one lung considerably congested (possibly some turpentine entered the windpipe); no parasites in the intestine. Previous to death chicken showed considerable difficulty in breathing.
147. ♀	do	2	3.5	3	....	
148. ♀	Black Spanish	3	5	2	....	
149. ♀	do	2	10	1	....	
150. ♀	do	2	5	5	....	
151. ♀	do	2	1.5	1	6	
152. ♀	Hamburg	3	8	4	....	
153. ♀	do	2	6	3	....	
154. ♀	Game	2	12	1	6	
155. ♀	do	1	10	......	6	

Thus, out of 32 chickens dosed with half an ounce (about 15^{cc}, about 1 tablespoonful, about 2 dessert-spoonfuls, about 4 teaspoonfuls) of spirits of turpentine, one died. In another case dosed with 25^{cc}, in still another dosed with 30^{cc} (about 1 ounce, or 2 tablespoonfuls) of turpentine-the animals were very sick, but recovered.

It will be well, therefore, to make half an ounce (about 15^{cc}, or 1 tablespoonful) the maximum dose. As a safe rule, we can adopt 1 teaspoonful (about 4^{cc}, about one-eighth on an ounce) to 3 teaspoonfuls (about 12^{cc}, about three-eighths of an ounce) as the dose for chickens, the size of the dose being determined by the size of the chicken.

It will be noticed that the above experiments were made to determine how much turpentine could be safely given to chickens. As there was no outbreak of tapeworm disease among the fowls used in the experiment, no observations could be made on the effects of the medicine upon the tapeworms which occur in chickens. Turpentine is, however, one of the recognized remedies against tapeworms.

Powdered kamala.—Mégnin states that very good results followed the use of this drug, mixed with the food, against tapeworms of pheasants. Hutcheon advises for ostrich chicks one month old 1 drachm, two months old 1½ drachms, three to four months old 2 drachms, eighteen months old 1 ounce, a full-grown ostrich 2 drachms more. It does not require to be mixed with a purgative. Powdered kamala may be given mixed in a little milk or water, or it may be made into pills with a little flour and water.

Pumpkin seeds.—These, according to Zürn, are not well borne by turkeys and not always by chickens, but it would be well to experiment further with them.

Pomegranate root bark.—Very effective against tapeworms in ostriches, but must be given in large doses and followed by a purgative. (Hutcheon).

Sulphate of copper (bluestone).—This is an excellent tæniacide in calves and lambs but the doses for fowls have not been determined.

In some experiments which are now in progress I have given 60^{cc} of a solution of 1 ounce sulphate of copper to 3 pints of water to a full-grown hen without noticing any ill effects from the dose. Thirty ^{cc} of the same mixture killed a half-grown rooster within twenty-four hours. Upon post-mortem it was found that the worms in the intestine were dead. Another half-grown chicken was dosed with 45^{cc} of the same mixture and bore the dose very well.

I am not prepared to recommend bluestone for chickens at present, except in experiments, and would direct attention to the danger of allowing the solution to enter the windpipe, as a very small dose of this solution will kill a fowl if the medicine reaches the respiratory organs. As a safe method of experiment, I have inserted a thin rubber tube to the crop (a catheter would answer equally as well) and forced the medicine through this tube. This method obviates the danger mentioned and is borne very well by the chickens. I caution again, that a large series of experiments in this line is needed before bluestone can be recommended for general use in dosing fowls.

Perroncito advises the following treatment for tapeworms in chickens (dose for one chicken):

(1) Aloes (socotrine or caballine), 15 to 20 centigrams. The animal is fasted the same day.

(2) Pumpkin seeds, 40 to 50. Administered to each chicken on the second day. Or—

(3) Male fern, powdered, 100 grams. Mixed in bran.

All of the above medicines should be procured as fresh as possible. Many failures in treating for tapeworms are due to the fact that old drugs have been used which had lost their anthelmintic properties.

PART II.

CLASSIFICATION.

Part II contains the descriptions of the tapeworms found in poultry and a discussion of the different species, and it is placed for the most part in fine type because of its rather technical nature. There are, however, a number of points mentioned under the various species which are necessary to the poultry raiser who desires to obtain a thorough knowledge of this subject. I have endeavored to bring together in Part II the entire history of each species, in order to show the exact status of our present knowledge of the group.

The Bureau is gradually collecting the original types of many of these species, with a view to revising the entire group and placing it upon a more scientific basis. It is our desire also to obtain all the material possible from various parts of this country, and we invite poultry raisers, etc., to send us specimens they may find in their birds. The Bureau will furnish bottles of alcohol or formalin, and mailing cases for such sendings. All correspondence should be directed to Dr. D. E. Salmon, Chief of the Bureau of Animal Industry, United States Department of Agriculture, Washington, D. C.

Worms sent to us for study or identification should first be washed in warm water and then placed in alcohol or in the preserving fluid furnished by the Bureau.

The following classification by genera is largely based upon the papers by Blanchard (1891B) and Railliet (1892B and 1893). In the specific diagnoses, the original descriptions and figures have been consulted as far as possible and data derived from them have been combined with more recent diagnoses and descriptions.

It would be well if authors making and publishing specific determinations in this group would preserve their specimens in some way, so that they may be used by later writers on the subject, for in many of the species described below the determination can be looked upon only as approximate and provisional. The specific determination of these forms is of much greater importance from a practical standpoint than is generally assumed, for an exact knowledge of the species is necessary as a foundation for general preventive measures.

Nomenclature.—In several places where it is perfectly evident that the parasites are now sailing under wrong names, I have corrected the names according to the international rules. In the majority of cases, however, I postpone changes until I can complete a revision of the entire group based upon original material.

In the systematic arrangement given below keys are given not only to the species of adult tapeworms of domestic fowls, but also to some closely allied forms. The allied genera and subfamilies are given in the keys in order to show the general relationships of the group.

The tapeworms of fowls belong to two families, the *Bothriocephalidæ* and *Tæniidæ*.

Regarding the generic position of the tapeworms of domesticated fowls it may be stated that up to within very recent years nearly all of the forms have been placed in the collective genus *Tænia*. To R. Blanchard and A. Railliet is due the chief credit of pointing out the absolute absurdity of uniting these forms generically with such forms as *Tænia solium* of man. True, other authors had recognized the great difference in some characters, but the group is such a difficult one to handle that helminthologists, either from lack of time, material, or courage, have carefully avoided any attempt at a natural classification.

Blanchard brought some order into the group in 1891 by proposing the new genera *Davainea* and *Echinocotyle* for certain forms, while Railliet followed up the work by proposing the genera *Drepanidotænia*, *Dicranotænia*, and *Bothriotænia* for certain other forms. These five new genera, together with *Mesocestoides*, *Ophryocotyle*, *Cotugnia*, and *Amabilia* enable us to make a provisional classification by genera. It should, however, be remembered that this classification is necessarily provisional in nature, as the internal anatomy of these worms is as yet very poorly understood, and a thorough study of that subject will probably result in great changes.

Regarding the species it may be again remarked that a considerable number of different forms have been described, but that a number of these species will unquestionably fall, while new species will have to be described for forms which are not yet recognizable as distinct.

ANALYTICAL KEY TO FAMILIES AND GENERA.

(*For genera already recorded in poultry follow italics.*)

1.	*Head with two elongated grooves or slit-like suckers; rostellum wanting; uterus with special pore; genital pores generally dorsal or ventral*	BOTHRIOCEPHALIDÆ, 2
	Head with four cup-shaped suckers; rostellum present but not always evident; uterus without any special pore; genital pores generally marginal	TÆNIIDÆ, 7
	Head is (always?) absent	17
2.	*Body without external segmentation; head without suckers, or two weak slit-like suckers develop (Ligulinæ)*	LIGULA, p. 27
	Body with external segmentation; head with two elongate slit or groove-like suckers	BOTHRIOCEPHALINÆ, 3
3.	*Genital organs single in each segment*	4
	Genital organs double in each segment	6

4.	*Genital pores lateral* (*marginal*)	BOTHRIOTÆNIA, p. 26
	Genital pores ventral or dorsal	5
5.	Penis, vulva, and uterus open ventro-median	BOTHRIOCEPHALUS, p. 25
	Penis and vulva ventro-median; uterine pore dorso-median	PTYCHOBOTHRIUM
6.	Penis, vulva, and uterus open ventrally	KRABBEA
	Penis and vulva ventral; uterus opens dorsally	DIPLOGONOPORUS
7.	Genital pores ventro-median (gen. *Mesocestoides*)	MESOCESTOIDINÆ, p. 28
	Genital pores lateral (*marginal*)	8
8.	Head never provided with hooks; uterus transverse or reticulate; egg generally with pyriform body; larval stage not known; adults in herbivorous mammals	ANOPLOCEPHALINÆ, p. 28
	Head nearly always provided with hooks (*T. saginata* exception, see also *Hymenolepis*)	9
9.	Egg with thin outer shell and thick brown inner shell; uterus median and longitudinal with lateral branches; larval stage a *Cysticercus*, *Cœnurus* or an *Echinococcus* generally in herbivora; adults in carnivorous mammals	TÆNIINÆ, p. 28
	Egg with thin transparent shells; frequently in egg capsules, in some cases scattered through the segment; head nearly always armed with hooklets on rostellum; larval stage a cysticercoid; adults in birds and mammals	DIPYLIDIINÆ, 10
10.	*Suckers unarmed*	11
	Suckers armed with minute hooklets (with four exceptions known only in birds)	16
11.	*Genital pores double*	12
	Genital pores single, irregularly alternate or unilateral	14
12.	*Two submedian ovaries in each segment*	13
	One median ovary in each segment	AMABILIA, p. 31
13.	Several rows of hooks upon rostellum	DIPYLIDIUM, p. 29
	A single row of hooks upon rostellum	COTUGNIA, p. 29
14.	*Dorsal*[1] *root of hooks much longer than ventral root or prong; ventral root very short; hooks 8 to 12* (*rarely to 26*) *in number; known only in birds*	DREPANIDOTÆNIA, p. 36
	Dorsal root of hooks about the same length as ventral root and prong	15
15.	*Dorsal root shorter than prong or ventral root; hooks generally less than 20 in number* (*range from 10 to 26*)*; genital pores unilateral or irregularly alternate; known only in birds*	DICRANOTÆNIA, p. 32
	Dorsal root longer than prong or ventral root; if rostellum is armed there are 24 to 30 hooks present; genital pores unilateral (on left of segments); 3 testicles normally present in each segment; retractile rostellum armed with minute hooklets or rudimentary and unarmed; eggs with 3 envelopes; parasitic in man, chiroptera, insectivora, rodents, and insectivorous birds; larval stage in insects or myriapoda	HYMENOLEPIS, p. 31

---

[1] As the terms *anterior* and *posterior* in referring to the roots of the hooks are reversed by some authors, I suggest the use of the words *dorsal* and *ventral* in their place. These words are not open to misinterpretation, the *dorsal* root being a continuation of the dorsum of the prong; the *ventral* root lies under the prong.

16.	*Hooks on suckers arranged in circular rows on border; hooks on rostellum resemble a hammer in form and arranged in a double row;* with four exceptions known only in birds	DAVAINEA, p. 45
	Hooks on suckers arranged in several transverse rows; hooks of infundibulum very small (4 μ) arranged in a single row; known only in birds....................	OPHRYOCOTYLE, p. 56
	Hooks on suckers arranged in one median set and two lateral sets; hooks on rostellum provided with long dorsal root and arranged in a single row; known only in birds.	ECHINOCOTYLE, p. 55
17.	*Anterior extremity of strobila expanded in form of a hammer*	FIMBRIARIA, p. 60
	Anterior segments become caliciform and function as a pseudoscolex	INDIOGENES, p. 60

Family **BOTHRIOCEPHALIDÆ.**

Diagnosis: Head provided with two groove or slit-like suckers; rostellum wanting; uterus with special pore; genital pores generally (possibly always) dorsal or ventral. Type genus: *Bothriocephalus* Rud., 1808.

The tapeworms of birds which belong to this family are classed in two (of the several) subfamilies. The forms recorded for the domesticated fowls are of little importance and the records of them are very incomplete. Three species have been reported from poultry. The first of these (*Ligula*) has been developed experimentally in ducks and pigeons; a second species (*Bothriotænia longicollis*) has been recorded but once from chickens, and a third form (a "*Bothriocephalide*") is recorded once from a pigeon.

Subfamily **Bothriocephalinæ.**

Diagnosis: Body with distinct external segmentation; head with two elongate slit or groove-like suckers. Type genus: *Bothriocephalus* Rud., 1808.

This subfamily contains among other forms the species mentioned above (*Bothriotænia longicollis*) from chickens, the undetermined genus and species from the pigeon and a number of species of the genus *Bothriocephalus* found in wild birds.

Although an unimportant subfamily so far as the domesticated fowls are concerned, it is quite an important one in human and comparative medicine. Six of its species (*Bothriocephalus latus*, *B. cristatus*, *B. cordatus*, *B. liguloides*, *B. Mansoni* and *Krabbea grandis*) occur in man, while several forms are recorded from dogs.

Genus **BOTHRIOCEPHALUS** Rudolphi, 1808.

(1819, *Dibothrius* Rudolphi; 1850, *Dibothrium* Diesing.)

Diagnosis: Two suckers present; penis, vulva, and uterus open ventro-median.

Type species:[1] *B. latus* (Linné, 1758), Bremser, 1819.

---

[1] If the rules of nomenclature were strictly adhered to there would be a general rearrangement of the species now included in *Bothriocephalus*. The species now known as *Ptychobothrium claviceps* (Goeze, 1782) was used by Rudolphi as the first species of *Bothriocephalus*, but within recent years *B. latus* of man has been tacitly

No species of this genus as at present revised (Blanchard, 1894, p. 699–702) is known to occur in domesticated fowls, although the pigeon "*Bothriocephalide*" may conveniently be placed here at present; several species (*B. dendriticus*, *B. ditremus*, *B. fissiceps*, *B. podicepedis*) are found in wild birds. For *Bothriocephalus longicollis* see *Bothriotænia longicollis*, p. 26.

1. **Bertkau's Pigeon Bothriocephalus**, gen. et sp. incert.

Cornelius (1875) mentions the occurrence of a tapeworm in a carrier pigeon at Eberfeld; he states that it was a true *Tænia*, but Bertkau, in a footnote to Cornelius's paper, remarks that it is a "*Bothriocephalide*," as it possessed two suckers.

The worm was yellowish white in color, 24^{cm} long; two suckers but no hooks on the head; neck short; anterior segments very short and straight, segments increasing in breadth to 6^{mm}, then decreasing again toward the posterior extremity; margin of strobila serrate.

The host had been listless and dull, but regained its natural condition after the expulsion of the worm.

Railliet (1893, p. 329), in referring to this form, mentions also a case recorded by Itzigsohn (Neudamm, Brandenburg). Dr. Itzigsohn was called to see a child which, he was assured, had vomited a worm, and, in fact, a *Bothriocephalus* was shown to him. An investigation, however, showed that the child had been playing with a pigeon, killed the evening before by the child's father; upon examining the bird a similar worm was found.

From the data given it is utterly impossible to determine these worms, and it appears useless to attempt it.

Genus **BOTHRIOTÆNIA** Railliet, 1892.

Diagnosis: Two suckers present; genital pores lateral (marginal). Type species *Bothriotænia longicollis* (Molin, 1858) Railliet, 1892.

2. **Bothriotænia longicollis** (Molin, 1858) Raillet, 1892.

(1858, *Dibothrium longicolle* Molin; 1878, *Bothriocephalus longicollis* (Molin, 1858) von Linstow).

Diagnosis: 18^{mm} to 27^{mm} long by 4^{mm} wide. Head small, claviform, thick, with 2 marginal oblong suckers, and a small central depression on the summit. Neck long and very thin. Body tænioid, flat, with 2 longitudinal grooves. Anterior segments very short; the following segments almost square, overlapping; posterior segments transverso-elliptic, thick with rounded borders. Gravid segments show a

---

understood by zoologists as representing the type species of the genus. This view, however, can not be accepted, as Rudolphi did not mention this form among his species of this genus. Strictly speaking, the generic name *Ptychobothrium* should fall into synonymy under *Bothriocephalus* (type *B. claviceps*) and a new generic term should be given to the group of which *B. latus* is now taken as type. This would, however, be a radical step and could be taken consistently only in a revision. Another solution of the problem, which would have the advantage of creating less confusion, would be to accept another species as type of *Bothriocephalus, which must obviously be one named by Rudolphi in 1808–1810,* with penis, vulva and uterus **opening ventrally.**

mosaic structure of dark, angular spots due to egg sacs. Genital pores unilateral, about in the middle of the margin.

Development: Unknown.

Host: Chickens (*Gallus domesticus*), by Molin.

Distribution: Pavia, Italy (by Molin and Polonio).

Molin seems to be the only author who has made any original observations on this worm, and these are not extended enough to give us any clear idea of the parasite in question. The egg sacs, unilateral pores, and the central depression on the summit of the head recall *Davainea* (vide p. 45), with the query whether Molin was really not in error in describing two suckers instead of four. Such an error would be an extremely easy one to fall into, as the suckers of avian cestodes are frequently indistinct or lost.

At all events, Molin's original specimens should be reexamined, as nearly forty years have now passed since the worm was first found; it has not been collected in recent years, although the chicken has frequently been examined for tapeworms.

Subfamily Ligulinæ.

Diagnosis: Body without distinct external segmentation; head without suckers, or two slit-like suckers may develop; genital pores ventral. Type genus *Ligula* Bloch, 1782.

Genus **LIGULA** Bloch, 1782.

Diagnosis: Body not segmented externally, but the genital organs are repeated and the three genital pores (penis, vulva, and uterine pore) of each set open ventrally; head without distinct suckers, or 2 longitudinal slit-like suckers may develop.

Life history: The larval form lives in the abdominal cavity of fish (particularly *Cyprinidæ*), the adult in the intestine of various piscivorous birds.

This genus does not normally occur in domesticated birds, but Duchamp (1876, quoted in Duchamp, 1877) infected ducks and pigeons (1877) with the larval form taken from the tench (*Tinca vulgaris*); he also (1878A) raised the adult in the peritoneal cavity of a dog. Donnadieu (1877) fed young ligules to ducks, and after twenty to thirty hours found adult ligules with eggs in these birds in some of his experiments, although in other infections of ducks his results were negative. Riehm (1882) also succeeded in infecting ducks with ligules.

From a piscicultural standpoint the immature stage of this parasite is of considerable importance, for it occasionally gives rise to serious epizootics among fish (for historical review, cf. Donnadieu, 1877).

A large number of species have been insufficiently described by various authors. Donnadieu unites them all with *Schistocephalus* under the name *Dibothrium ligula;* other authors, however, are inclined to recognize two species, i. e., *Ligula uniserialis* Rud., 1810 (Syn. 1839, *L. monogramma* Creplin), and *Ligula alternans* Rud., 1810 (Syn. 1839, *L. digramma* Creplin). The term *L. simplicissima* Rud., 1802, is generally applied to the asexual form in fish.

Genital organs simple, uniserial .... *L. uniserialis.*
Genital organs double and alternating .... *L. alternans.*

Family **TÆNIIDÆ**

Diagnosis: Head with 4 cup-shaped suckers; rostellum present but not always evident; uterine pore wanting; genital pores generally marginal; body always segmented. Type genus: *Tænia* Linné, 1758.

This family is an extremely important one from an agricultural standpoint as all the tapeworms of domesticated animals (with the exception of a few belonging to the *Bothriocephalidæ*) are classified here. Probably all of the tapeworms normally found in poultry belong to the subfamily *Dipylidiinæ.*

The subfamily *Tæniinæ*[1] (type genus: *Tænia* Linné, 1758) contains mostly large tapeworms, the adult stage of which lives in carnivorous animals (*T. saginata* of man, *T. marginata* of dogs, for instance) while the larval stage lives in herbivorous animals (*Cysticercus bovis* of cattle, *C. tenuicollis* of sheep, cattle, etc.).

The subfamily *Anoplocephalinæ* (type genus: *Anoplocephala* E. Bl., 1848) contains most of the adult tapeworms of horses, cattle, sheep, rabbits, and allied animals.

Subfamily **Mesocestoidinæ.**

Diagnosis: Head with four suckers; segments distinct; genital pores in median ventral line. Type and only genus: *Mesocestoides* Vaillant, 1863.

Genus **MESOCESTOIDES** Vaillant, 1863.

(1885, *Ptychophysa* Hamann.)

Diagnosis: Char. of subfamily; a single egg sac present. Type species: *M. ambiguus* Vaillant, 1863.

Railliett (1893, p. 313) places Polonio's *Tænia imbutiformis* of wild geese in this genus as a *species inquirenda*, but I can not recognize Polonio's description and figure as supporting this view (vide p. 58). This genus would, therefore, according to my view, be without any representative among the parasites of domesticated birds. The type species *M. ambiguus* is found in *Gennetta gennetta* (Linné, 1758) [*Viverra genetta*], and one species, *M. lineatus* (Goeze, 1782) Railliett, 1893, is found in dogs and cats.

Subfamily **Dipylidiinæ.**

(1858, *Malacolepidota* Weinland—Soft-shell tapeworms; 1863, *Cystoideæ* Leuckart; *Cystoidei; Cystoidotæniæ; Tænia* (*Microtænia*).

Diagnosis: Head with 4 suckers; rostellum generally armed; genital pores lateral (marginal), single or double; egg with thin transparent shells, frequently arranged in egg sacs, in some cases scattered through the segments; larval stage a cysticercoid; adults in birds and mammals. Type genus: *Dipylidium* R. Leuckart, 1863.

Probably all of the *Tæniidæ* of birds belong to this subfamily, which is at present divided into nine genera. The tapeworms of domesticated fowls are confined to the five genera: *Cotugnia, Davainea, Dicranotænia, Drepanidotænia,* and *Echinocotyle.*

---

[1] Syn. 1858, Sclerolepidota Weinland (hard-shell tapeworms); *Cysticæ; Cystotæniæ.*

I. Genital pores double and opposite. Suckers unarmed.

Three different genera have been proposed in the subfamily *Dipylidiinæ* for forms with double and opposite genital pores, but they have been very poorly defined from one another.

The genus *Dipylidium* contains species which infest mammals, and with *D. caninum* as type species will unquestionably stand as a good genus. In birds several forms with double genital pores have also been described. *Tænia digonopora* Pasquale in chickens and *Tænia bifaria* Siebold in *Aythya nyroca* (*Nyroca leucophthalma*) have been placed by Diamare (1893A) in a new genus *Cotugnia*, which, however, he fails to define distinctly from *Dipylidium*, and which must unquestionably be suppressed unless better characters are brought to its support. Diamare (1893A) has also proposed the genus *Amabilia* for *Tænia lamelligera* in the flamingo (*Phœnicopterus antiquorum*).

Too little is known of the other forms described as possessing double genital pores to allow a determination of their generic affinities, and speculation in this direction would simply complicate matters; the forms which must be taken into consideration are *Tænia polymorpha* Rudolphi, 1819, pars (as determined by Krabbe 1869, p. 301) from *Recurvirostra avocetta* and "*Tænia lævis* Bloch (Diesing)" (see Krabbe, 1869, p. 302), from *Aythya ferina* [*Fuligula ferina*].

In deference to my Italian colleague Diamare, I adopt his genera provisionally, postponing final opinion in regard to them until his more detailed publication appears.

a. Two submedian ovaries in each segment.

a′. Hooks on rostellum arranged in several rows.

Genus **DIPYLIDIUM** R. Leuckart, 1863.[1]

(1858, *Alyselminthus* Zeder, 1800, partim Weinland.)

Diagnosis: Rostellum retractile, armed with several transverse rows of alternating hooks; hooks with small roots, the base being discoidal; mature segments elongate with double sets of genital organs; pores double and opposite; testicles very numerous, scattered through the median field; ovary bilobled; vitellogene glands distal; uterus at first reticulate among the testicles, finally resolving itself into independent egg sacs containing one or several ova; ova with double transparent membranes. Type species: *D. caninum* (Linné, 1767).

No members of this genus have as yet been recorded from birds. The type species *D. caninum* inhabits the intestine of dogs, cats, and man; its larval stage lives in fleas (*Pulex serraticeps P. irritans*) and lice (*Trichodectes canis*).

a″. Hooks on head arranged in a single row.

Genus **COTUGNIA** Diamare, 1893. (Gen. inq.).

Diagnosis: Head large, with a rudimentary retractile rostellum armed with a large number of very minute hooklets arranged in a single row, prong thick and short, without dorsal root, with ventral root thin and elongate toward the point. Suckers large and unarmed. Mature segments broader than long. Genital organs double, opening separately each on its respective lateral margin. Uterus composed of egg sacs. Type species: *Cotugnia digonopora* (Pasquale, 1890) Diamare, 1893.

---

[1] For full bibliography consult Diamare's monograph (1893) *Il Genere Dipylidium* Lkt. < Atti. R. Accad. Scienze fisiche e matematiche, Vol. VI, ser. 2*a*, No. 7, 31 pages, 3 plates. Care should, however, be exercised in accepting the dates given by Diamare as many typographical errors have crept into the bibliography.

This genus was established by Diamare for a tapeworm which occurs in chickens. The diagnosis as at present given by Diamare fails, in my opinion, to separate the genus distinctly from *Dipylidium*. Two species have been described, but insufficiency of details in the specific diagnoses does not allow a satisfactory morphological distinction at present.

{ Found in chickens .... *C. digonopora.*
{ Found in ducks.. *C. bifaria.*

3. **Cotugnia digonopora** (Pasquale, 1890) Diamare, 1893. The double-pored chicken tapeworm.

(1890, *Tænia digonopora* Pasquale.)

[Pl. I, figs. 1–11.]

Diagnosis: Strobila 40^{mm} to 80^{mm} long by 8^{mm} broad and in contracted condition about 1^{mm} thick; head 1.4^{mm} by 1.12^{mm}; rostellum with a crowded crown (in a single row) of very small hooks 8.35 μ long; base of rostellum 0.22^{mm} by 0.15^{mm}; suckers globular, prominent, 0.35^{mm} in diameter. Neck short. Anterior segments broader than long, posterior segments longer than broad. Genital pores double in about the middle of the lateral margins; 2 ovaries in each segment; eggs evidently arranged in egg sacs.

Life history: Unknown.

Host: Chicken (*Gallus domesticus*) by Pasquale.

Geographical distribution: Abyssinia, by Pasquale.

Pasquale (1890) found this worm quite common in chickens in Massowah and thinks it probable that the poor condition of the fowls was due to its presence. It was frequently present in the cæca as well as in the small intestine.

4. **Cotugnia bifaria** (von Siebold, 1848) Diamare, 1893. The double-pored duck tapeworm.

(1848, *Tænia bifaria* von Siebold; 1871, *T. tuberculata* Krefft [nec Rudolphi, 1819].)

[Pl. II, figs. 12–17.]

Diagnosis: Strobila 39^{mm} to 90^{mm} long by (?) broad. Head triangular, with conical, pointed, (?) unarmed rostellum and 4 small unarmed circular suckers; neck short. Proximal segments small, narrow, gradually enlarged, and rectangular; distal segments the largest, subquadrate. Genital pores double, one each side in about the middle of the margin, prominent in sexually active segments. *Male organs:* Testicles few in number; each vas deferens inflated into a vesicula seminalis near the anterior margin of the segment, somewhat laterally of the median line; from here the seminal canal runs diagonally to the cirrus pouch, which is large; cirrus covered with minute spines. *Female organs:* Not well understoood; evidently 2 ovaries present in the posterior portion of the segment, one each side of the median line.

Life history: Unknown.

Type specimen: Collection Siebold in British Museum.

Hosts: African Teal (*Aythya nyroca*), by von Siebold; White-eyed duck, *A. australis* (Gould), by Krefft.

Geographical distribution: ———— by von Siebold; Australia, by Krefft.

Von Siebold (1848, p. 147) mentions *Tænia bifaria* from the intestine of *Anas leucophthalmos* (= *Aythya nyroca*). The specimens possessed double genital pores similar to *D. caninum*. Monticelli (1889, p. 325) examined these specimens, preserved in the British Museum, and gave a short diagnosis. In another paper (1891, pp. 151–153) he gives a more extended description, together with figures. He did not observe hooks on the head but will not deny their presence. Monticelli states that Krefft's species "*T. tubercolata*" (= *T. tuberculata*), described from *Aythya australis* (Gould), is identical with *T. bifaria*. Diamare (1893, p. 12) places *T. bifaria* in the genus *Cotugnia*.

b. One median ovary in each segment.

Genus **AMABILIA** Diamare, 1893. (Gen. inq.)

Diagnosis: Avian cestode with double lateral genital pores; double cirri; ovary single and median. Type species: *Amabilia lamelligera* (Owen, 1835) Diamare, 1893.

This genus was proposed recently in a preliminary communication by Diamare. A more complete knowledge of the worm is necessary before it will be possible to judge whether the genus is well founded or not. No member of the genus has yet been recorded in domesticated fowls, but the type and only species is found in the flamingo.

5. **Amabilia lamelligera** (Owen, 1835) Diamare, 1893.

(1835, *Tænia lamelligera* Owen.)

[Pl. II, figs. 18–20.]

Diagnosis: Strobila 120^{mm} to 170^{mm} long, 10.5^{mm} broad, 2.1^{mm} thick. Head almost globular; rostellum cylindrical, obtuse; armature? Neck absent; segments very short. Genital pores double; ovary single and median. Ova segregated near base of penis.

Hosts: Flamingo[1] (*Phœnicopterus antiquorum*).

Geographical distribution: ? by Sykes; France by Gervais; ? Sardinia (? Cagliari) by Ficalbi.

II. Genital pores single. Suckers armed or unarmed.

A. Suckers unarmed: genera *Hymenolepis*, *Dicranotænia*, and *Drepanidotænia*.

Genus **HYMENOLEPIS** Weinland, 1858.

(1858, *Diplacanthus* Weinland [nec L. Agassiz].)

Diagnosis: Strobila small (filiform). Head small, provided with a retractile rostellum, well developed and armed with a single crown of 24–30 hooklets, or rudimentary and unarmed. (Neck long. Segments serrate, much broader than long, rarely less than 150 in number.) Genital pores marginal, sinistral, the female surface of the proglottid representing ventral. Testicles few, generally 3 in each segment, one left and two right of the median line. Gravid segments transformed into a sac full of eggs; eggs surrounded by 3 shells separated one from another. Inner shell without pyriform body, but occasionally with a small knob at each pole. Larva is a

---

[1] Owen states that his specimens were collected by Lieutenant-Colonel Sykes "in a *Flamingo, Phœnicopterus ruber*, Linn." Diamare states that his own specimens were collected by "Professor Ficalbi, della R. Universita di Cagliari," from "*Phœnicopterus roseus*." According to Dr. T. S. Palmer, the Old World flamingoes are *P. antiquorum* Temm. (syn. *P. roseus* Pallas), *P. erythræus*, and *P. minor;* the New World flamingoes are *P. ruber* Linn., and *P. ignipalliatus*. In Owen's time, however, all flamingoes were included under the name *P. ruber* Linn. As it was not stated where Sykes collected his material it is impossible to determine the host species definitely, but upon Dr. Palmer's advice I take *P. antiquorum* as host.

Cryptocystis or *Staphylocystis;* intermediate host an insect or myriapode. Type species: *H. diminuta* (Rud., 1819).

(Revised generic characters from Blanchard, 1891C, pp. 49–50. I inclose in brackets several characters which I can hardly look upon as generic. For bibliography see R. Blanchard, 1891C.)

Weinland proposed this genus with *Tænia flavopunctata* as type, but as this form is identical with *Tænia diminuta* the name *H. diminuta* is here inserted as type species. At the same time he proposed a genus *Diplacanthus* (nec L. Agassiz) with *Tænia nana* von Siebold as type species. The term *Diplacanthus* must drop, as it is preoccupied, and there seems to be no good grounds for separating *H. nana* generically from *H. diminuta.*

Weinland divided *Hymenolepis* into two subgenera: (1) *Lepidotrias* Weinland, 1858 (with 3 eggshells) with *H. murina* (Dujardin, 1845) Weinland, 1858, as type species, and including *Tænia scalaris, scutigera, tiara, pistillum, microstoma, nasuta, undulata, serpentulus, crateriformis, sinuosa* and *flavopunctata;* (2) *Dilepis* Weinland, 1858 (with 2 eggshells), with *T. angulata* Rud. as type species, and containing *T. purpurata, porosa* and *lanceolata.* Of these forms *T. sinuosa* (vide *Drepanidotænia sinuosa* p. 40) and *T. lanceolata* (vide *Dr. lanceolata* p. 36) occur in domestic fowls.

Most of the species of this genus are parasitic in mammals, but Weinland included a number of avian tapeworms in *Hymenolepis.* Blanchard (1891C, pp. 68–69) discusses the forms and concludes that only four avian species can be included here with any degree of probability. These species mentioned below do not occur in domesticated fowls.

Hymenolepis serpentulus (Schrank, 1798) Weinland, 1858. (Syn. 1798, *Tænia serpentulus* Schrank [nec Duj., 1845]), found in *Oriolus galbula, Corvus cornix, C. corone, C. frugilegus, C. monedula, Nucifraga caryocatactes, Garrulus glandarius, Pica caudata, Picus aurulentus.*

Hymenolepis angulata (Rud., 1810) Weinland, 1858. (Syn. 1810, *Tænia angulata* Rud.; 1845, *T. serpentulus* Duj. [nec Schrank, 1798]); found in *Nucifraga caryocatactes, Turdus atrigularis, T. iliacus, T. merula, T. musicus, T. pilaris, T. saxatilis, T. torquatus, T. viscivorus, Oriolus galbula, Pica caudata.*

Hymenolepis nasuta (Rud., 1802), Weinland, 1858. (Syn. 1802, *Tænia nasuta* Rudolphi); found in *Parus major, P. caudatus, P. cœruleus, P. cristatus, P. palustris.*

Hymenolepis farciminalis (Batsch, 1786), R. Bl., 1891. (Syn. 1786, *Tænia farciminalis* Batsch; 1845, *T. undulata* Duj.); found in *Sturnus vulgaris, Garrulus glandarius.*

Genus **DICRANOTÆNIA** Railliet, 1892.

Diagnosis: Rostellum provided with a single row of short, uniform hooks, generally few (10–26) in number, with the ventral root equal to or longer than the dorsal root, and forming with the prong a small pitchfork. Type species: *Dicranotænia coronula* (Dujardin) Railliet.

Development: The larval cysticercoids develop in small crustaceans.

From the characters thus far given it is very difficult to distinguish this genus from *Hymenolepis.*

1	Genital pores alternate; rostellum with 12 hooks 32 μ long; found in chickens	*D. sphenoides*, p. 35
	Genital pores unilateral	2
2	Rostellum with 18 to 26 hooks 13 μ to 17 μ long; found in ducks	*D. coronula*, p. 33
	Rostellum with 10 hooks	3
3	Hooks 27 μ to 32 μ long; found in swans and big scaup duck	*D. æquabilis*, p. 33
	Hooks 47 μ to 66 μ long; found in wild ducks	*D. furcigera*, p. 34

a. Genital pores unilateral.

6. Dicranotænia coronula (Dujardin, 1845) Railliet, 1892.

(1845, *Tænia coronula* Duj.)

[Pl. III, figs. 21–28.]

Diagnosis: 120^{mm} to 190^{mm} long, 1.5^{mm} to 3^{mm} broad. Head almost rhomboidal, 0.20^{mm} to 0.22^{mm}; suckers prominent, angular, irregular, 0.066^{mm} to 0.09^{mm} in diameter; rostellum thick, 0.09^{mm} by 0.06^{mm}, surrounded by a simple crown of 18–26 hooks 9 μ to 14 μ (Dujardin), 14 μ to 15 μ (Krabbe), 13 μ to 17 μ (Railliet) long. Anterior segments very short; following segments gradually increase in size. Genital pores unilateral. Penis 60 μ to 80 μ (Duj.) 110 μ (Krabbe) long by 30 μ to 53 μ broad, but able to swell to 80 μ, covered with minute spines. Hooks of embryo 8 μ. Internal anatomy?

Development: Cysticercoid, probably in mussel crabs (*Cypris ovum* Jur., *Cypris cinerea, Cypria ophthalmica* Jur. and *Candona candida*.

Hosts: Tame ducks (*Anas boschas dom.*); Mallard duck (*A. boschas* L.); European Golden Eye (*Glaucionetta clangula*).

Geographical distribution: France (at Rennes, by Dujardin; at Alfort, by Railliet); Denmark (in Zealand by Krabbe); Germany (in Bavaria by von Siebold, after Krabbe; in Munich by von Willemoes-Suhm, after Krabbe, 1882). No epidemics reported.

Dujardin (1845, p. 574) described this species from parasites found in ducks at Rennes; Krabbe (1869, pp. 317–318) found the same species in domesticated ducks and adds a few observations, chiefly measurements; he cites it from Siebold's collection (from *Glancionetta clangula*) and in 1882, p. 356, cites it from von Willemoes-Suhm (from *Anas boschas fera*). Railliet (1893, p. 303) has found young tapeworms in the domesticated duck at Alfort, which he determined as belonging to this species, although the dorsal root of the hooks were much more slender than those figured by Krabbe. These appear to be the only observations upon the adult worm, which as at present diagnosed, is based entirely upon external characters, and which, therefore, should be restudied anatomically.

Several authors have found larval cestodes in fresh-water mussel crabs which they look upon as the young stage of *Dicr. coronula*.

Mrázek (1890) [in a publication which on account of the language I am unable to read, I quote from Moniez (1891, p. 26) and Railliet (1893)] has found a cysticercoid in *Cypris ovum* Jur. and in *Cypris ophthalmica* Jur. (*Cypris compressa* Baird) which measures 140 μ to 190 μ in diameter, and is provided with 22 to 31 hooks corresponding in form and dimensions to those figured by Krabbe, except that the dorsal root is somewhat more slender; the tail is 3 to 5 times as long as the body and bears the 6 hooks (8 μ long) of the oncosphere. Rosseter (1890) describes and figures the cysticercoid of *D. coronula* from *Cypris cinerea* in Kent. Moniez (1891, p. 26) states that this cysticercoid is rather common in France, where he has found it in *Cypria ophthalmica* and *Candona candida;* he also records it in *Cy. ophthalmica* from Durham and from China.

While it will be noticed that this cysticercoid is very similar to *Dicr. coronula* and that in all probability it represents its larval stage, it must not be forgotten that the experimental proof of the relationship of these organisms has not yet been forthcoming, and furthermore, that even the adult form is very superficially described.

7. Dicranotænia æquabilis (Rudolphi, 1810) Railliet, 1893.

(1810, *Tænia æquabilis* Rudolphi.)

[Pl. III, figs. 29–30.]

Diagnosis: 160^{mm} to 350^{mm} long, 3.2^{mm} to 4.6^{mm} broad. Head subglobular; rostellum obovate, armed with a simple crown of 10 hooks 27 μ to 32 μ long; suckers rather large, orbicular, prominent. Neck very short. Anterior segments very short and thin; following segments trapezoidal, much broader than long, posterior angles acute, but becoming more rounded near the posterior end. Genital pores unilateral. Development unknown.

Hosts: European swan (*Olor cygnus*); ? domesticated swan (*O. cygnus dom.*); Widgeon (*Anas penelope*); European scaup duck (*Aythya marila*).

Geographical distribution: Pomerania (by Rudolphi and Creplin); Schleswig (by Friis). Epidemics: None reported.

Like the preceding species, this form has been seen but a few times and is established entirely upon external characters.

Rudolphi collected it originally and described it in 1810 (pp. 135–136) from wild swan. In 1819 (p. 155) he gives "*Anas olor*" as a host. According to Diesing (1850, p. 527) Bremser found it in *Olor cygnus*. Bellingham (1844, p. 320) quotes it for "*Cygnus ferus* and *Mareca penelope*." Krabbe (1869, pp. 316–317) examined the originals and figured the hooks; he cites it further from Creplin's collection, and mentions that Friis also found it. "Gervais and van Beneden, afterwards von Linstow, cite it, probably erroneously, from the domesticated swan" (Railliet). Von Linstow (1878, p. 158) records it for *Fuligula marila* (= *Aythya marila*), but does not give the collector.

8. **Dicranotænia furcigera** (Rudolphi, 1819) Stiles, 1896.

(1819, "*T. trilineata* Batsch" of Rudolphi; 1819, T. *furcigera* Rudolphi ex Nitzsch, MS.; 1845, *T. rhomboidea* Duj.; 1893, *Dicranotænia rhomboidea* (Dujardin, 1845) Railliet.) (? 1779, *Tænia lineata* Bloch; ? 1786, *T. trilineata* Batsch; ? 1790, *T. Anatis* β *lineata* Gmelin; ? 1802, *T. longirostris* Frölich [nec Rud., 1819]; ? 1803, *Halysis trilineata* (Batsch, 1786) Zeder; ? 1858, *T. conica* Molin.)

[Pl. III, figs. 31–34 (35–36).]

Diagnosis: 10^{mm} to 35^{mm} long by 0.5 to 1^{mm} broad. Head 0.46^{mm} to 0.52, rhomboidal, or prolonged anteriorily in a tube containing a thick ovoide, oblong, rostellum 0.22^{mm} to 0.25^{mm} broad by 0.27^{mm} long, armed with a single crown of hooks 65 μ to 66 μ (Dujardin), 48 μ to 58 μ (Krabbe) long. Suckers 0.18^{mm} in diameter. Segments trapezoidal, 2 to 3 times longer than broad. Genital pores unilateral. Penis 9.7 μ broad, smooth. Embryo 36 μ; hooks of embryo 14 μ (Krabbe), 16 μ to 17 μ (Dujardin). Development not known.

Hosts: Mallard ducks (*Anas boschas*) by Dujardin, Nitzch, Krabbe, Friis; Pochard (*Aythya ferina*); is erroneously stated to have been found in domestic ducks, according to Railliet. See also hosts for *T. conica*, *T. lineata*, and *T. trilineata*, in chart at end of text, taken from von Linstow, 1878, and others.

Geographical distribution: France (by Dujardin), Italy (by de Ninni), Iceland (Krabbe), Schleswig (Friis). Epidemics, none recorded.

The early history of this worm is buried under indefinite and incomplete statements upon superficially studied material. We can, however, trace the species with certainty as far back as Rudolphi, 1819, p. 528. Nitzsch collected some worms from the Mallard in 1816, and sent them to Rudolphi, evidently under the MS. label *Tænia furcigera*. Rudolphi determined the worms as *T. trilineata* Batsch, 1786, which, according to Krabbe (1869, p. 315) (Batsch's original not at my disposal), is a name Batsch introduced for Bloch's *T. lineata* of 1779. Krabbe afterward examined Nitzsch's specimens, and states (1869, p. 315) that they are identical with *T. rhomboidea* Dujardin, 1845. I adopt Nitzsch's name for the reasons given in the footnote.[1]

---

[1] A very delicate point of nomenclature is involved in this case, and one which has been entirely overlooked by helminthologists. In the first place, the name *trilineata* should be suppressed because (Krabbe, 1869, p. 315) it was originally intended for a species (i. e., *T. lineata* from *A. penelope*, *A. circia*, *Dafila acuta*) already named

Dujardin (1845, pp. 574–575, *T. rhomboidea*) found a 30^{mm} fragment and 6 young worms 10^{mm} to 18^{mm} long in a wild duck, in which "*Tænia megalops*" was also present. In Iceland Krabbe collected numerous young specimens of *T. rhomboidea* from wild ducks (*A. boschas fera*); they were 10^{mm} long by 0.5^{mm} broad; the rostellum was armed with 10 hooks, 47 μ to 58 μ long; genital apparatus not visible. Friis (Krabbe, 1869) collected the same species in Schleswig, and Krabbe thinks that the worm which Molin (1858, p. 139; 1861, p. 253, Taf. VII, figs. 1–2) found in wild ducks in Padua and described under the name *T. conica* is also identical with Dujardin's *T. rhomboidea*. Molin records his form from *Anas boschas;* von Linstow (1878) gives it for *A. boschas dom.*, but not for *A. boschas*. Railliet (1893, p. 303) places *T. rhomboidea* in the genus *Dicranotænia*, and calls attention to the error in Diesing (1850, p. 543) of including *T. trilineata* as a parasite of the domestic duck—an error repeated by von Linstow. Railliet thinks that *T. trilineata* Batsch, 1786, is identical with *T. rhomboidea*, although Dujardin (1845) thinks that *T. trilineata* is simply a variety of *T. sinuosa*.

There seems no way either to prove or disprove what species *T. trilineata* Batsch (= *T. lineata* Bloch) really represents, unless the types can be procured. In view of the poor descriptions I intend for the present to ignore these specific names entirely.

b. Genital pores alternate.

9. Dicranotænia sphenoides (Railliet, 1892) Railliet, 1896.

(1872, *Tænia cuneata* von Linstow [nec Batsch, 1786]; 1892, *T. sphenoides* Raill.; 1893, *Dicranotænia cuneata* (von Linstow, 1872) Raill.)

[Pl. IV, figs. 37–42.]

Diagnosis: Body 2^{mm} (von Linstow) to 4^{mm} (Magalhães) long, by 1^{mm} broad, wedge-shaped; head 200 μ long by 205 μ broad, contracted posteriorly to form the neck; retractile rostellum cylindrical, 150 μ long by 37.5 μ broad, bearing 12 (von Linstow, Magalhães, Piana) or 12–14 (Grassi & Rovelli) hooks which measure 25 μ (Magalhães) or 32 μ (other authors) long; dorsal root of hooks short and same length as ventral root. Suckers round to oval, 75 μ in diameter, unarmed. Segments 12–13 in number, increasing gradually in size from the first to the last, so that the entire body is wedge-shaped. Genital pores irregularly alternate, situated at the anterior angle of the segments; male organs appear in first segment, testicles "numerous," vitellaria seen in ninth and following segments; mature eggs seen only in twelfth and thirteenth segments; they lie in 12–13 large vesicles which finally break, the eggs being scattered through the segments. Eggs spherical, 42 μ in diameter, with 2 membranes; hooks of oncosphere, 6 μ.

Development: Intermediate host is probably an earthworm (*Allobophora fœtida* Eisen). The cysticercoid has no tail.

Host: Chickens (*Gallus domesticus*).

Geographical distribution: Germany (von Linstow); Italy (Grassi & Rovelli); South America—Brazil (Magalhães).

---

and figured. Accordingly, *trilineata* should never have been proposed, and hence can not be taken into consideration under any circumstances. Krabbe states that the description and figures of *T. lineata* are so imperfect that it is not possible to determine the species with certainty, although from Bloch's figures it is not probable that his worm is identical with *T. rhomboidea*. This statement relieves us from considering *T. lineata* further unless Bloch's specimens can be found. Authors have generally accepted Dujardin's specific name, but the publication of Nitzsch's name by Rudolphi establishes the date of *T. furcigera* as 1819, and associates the name with Rudolphi's description. Krabbe's establishment of the identity of *T. rhomboidea* with *T. furcigera* must naturally suppress Dujardin's name. Accordingly, Nitzsch's specimens are the oldest types as yet consulted, and nothing remains at present but to accept Rudolphi's publication of this name.

Von Linstow (1872B, pp. 56–57) discovered this worm in chickens in Germany, and described it as *Tænia cuneata*. Piana (1882, p. 393–394) evidently examined some of von Linstow's originals, but does not add much to the diagnosis. Grassi & Rovelli (1889A, p. 404; 1892, pp. 29–30, 88–90) found the same species in Italy; they found some cysticercoids in an earthworm (*Allobophora fœtida*), which they believe represent the larval stage of *T. cuneata*. They evidently, however, did not make any experiments to determine this point, although they state that the hooks agree with the hooks of *T. cuneata*. This supposed intermediate host must therefore be subjected to experimentation before Grassi & Rovelli's statements are given full credence. Magalhães (1892, pp. 145–146) records the same species from Brazil, adding several important points on the anatomy of the worm. Railliet (1892, p. 53) uses the term *Tænia sphenoides* for this worm, his ground evidently being that the term *T. cuneata* is already preoccupied. In 1893 (p. 304) he reverts to the specific name *cuneata*, placing the form in *Dicranotænia*. By the international rules the term *cuneata* must fall, on which account I accept the next available name, *sphenoides*. (See addendum, p. 61.)

Genus **DREPANIDOTÆNIA** Railliet, 1892.

Diagnosis: Head provided with a single row of uniform hooks, few (8–20) in number, with dorsal root much longer than ventral root, the latter always small; with prong directed posteriorly when the rostellum contracts. Type species *Dr. lanceolata* (Bloch, 1782) Railliet 1892.

Development: The larval stage (cysticercoid) of several species has been found in small crustaceans.

1. Genital pores alternate; rostellum with 16–20 hooks 20–27 μ long; Hab: chickens, ? pheasants, ? ducks, pigeons .... *Dr. infundibuliformis*, p. 43
   Genital pores unilateral 2
2. Rostellum with 10 hooks 3
   Rostellum with 8 hooks 4
3. Hooks 20 μ to 23 μ long; found in ducks, domestic goose, and wild goosander .... *Dr. tenuirostris*, p. 43
   Hooks 35 μ to 40 μ long; found in geese .... *Dr. setigera*, p. 41
   Hooks 51 μ to 61 μ long; found in geese .... *Dr. sinuosa*, p. 40
   Hooks 65 μ to 72 μ long; found in ducks .... *Dr. anatina*, p. 39
4. Hooks 31 μ to 35 μ long; found in ducks and geese .... *Dr. lanceolata*, p. 36
   Hooks 57 μ long; found in geese .... *Dr. fasciata*, p. 37
   Hooks 77 μ to 80 μ long; found in ducks and geese .... *Dr. gracilis*, p. 38

A. Genital pore unilateral.
a. Rostellum with 8 hooks.

10. Drepanidotænia lanceolata (Bloch, 1782) Railliet, 1892. The lanceolate tapeworm.

(1727, *Tænia anserum* Frisch—vide Rud., 1810; 1781, *T. acutissima* Pallas, pars—vide Krabbe, 1869; 1779, *T. anseris* Bloch—vide Rud., 1810; 1782, *T. lanceolata* Bloch; 1786, *T. lanceola* Batsch—vide Rud., 1810; 1803, *Halysis lanceolata* (Bloch, 1782) Zeder—vide Rud., 1810; 1858, *Hymenolepis* (*Dilepis*) *lanceolata* (Bloch, 1782) Weinland.)

[Pl. IV, Figs. 43–53; Pl. V, Figs. 54–55.]

Diagnosis: 30^{mm} to 130^{mm} long by 5^{mm} to 18^{mm} broad. Head very small, globular; rostellum cylindrical, slightly swollen on the summit, armed with a single crown of 8 hooks 31 μ to 35 μ long; suckers rounded. Neck very short, can be retracted with the head into the anterior portion of the strobila. Anterior segments very short, the following segments increasing slightly in length and becoming gradually broader to within a short distance of the posterior extremity when they become narrower, giving the body a lancet shape. Genital pores unilateral, near anterior corner of segment; penis armed with spines; cirrus-pouch small; testicles 3; female organs on opposite side of segment from genital pore (Feuereisen). Eggs with very thin external shell 50 μ by 35 μ; hooks of oncosphere 8 μ. Development: Unknown.

Hosts: Tame duck (*Anas boschas dom.*); black duck (*Anas obscura*); tame goose (*Anser anser dom.*); muscovy duck (*Cairina moschata*); white-headed duck (*Erismatura leucocephala*); pochard (*Aythya ferina*); African teal (*Aythya nyroca*); red-crested pochard (*Aythya rufina*); flamingo (*Phœnicopterus antiquorum*).

Geographical distribution: England, Denmark, France, Germany, and Austria. Epidemic in 1710, reported by Frisch.

Bloch (1782, p. 7–9) found this worm more especially among lean geese; Goeze (1782, pp. 377–383) says that it is most common in lean geese which have been allowed to roam; Dujardin (1845, p. 562) mentions *T. lanceolata* as possessing 10 hooks and irregularly alternating genital pores, which makes it probable that he did not have this species before him. Krabbe (1869, pp. 295–296) found this form in 77 geese out of 400 examined, or about 20 per cent. The Vienna catalogue gives *T. lanceolata* and *T. sinuosa* together for 19 out of 139 tame geese. The epidemic of 1710 recorded by Frisch (1727; 1781, pp. 155–156) is attributed to this species. It has been found by various German authors. Mégnin (1881A, pp. 29–32) has found it in ducks and geese in France, Railliet (1893, pp. 299–300) in Ardennes France, Lucet in Loiret, France. Railliet states that this is the most common form in geese. Hassall has one specimen from Liverpool, England.

Authors generally consider that there is little or no difficulty in recognizing this species, its anatomy, however, is very imperfectly understood.

11. Drepanidotænia fasciata ([? Rudolphi, 1810] Krabbe, 1869) Railliet, 1893.
(1868, "*T. setigera* Frölich," 1789 of Feuereisen [nec Frölich of v. Siebold, 1848]; 1869, *T. fasciata* Krabbe.)
(? 1800, *Alyselminthus crenatus* (Goeze, 1782) Zeder pars—vide Rud., 1810; ? 1803, *Halysis crenata* (Goeze, 1782) Zeder pars—vide Rud., 1810; ? 1810, *Tænia fasciata* Rud.).

[Pl. V, figs. 56–66; Pl. VI, figs. 67–76; Pl. VII. figs. 77–79.]

Diagnosis: Body 60^{mm} to 160^{mm} long by 1^{mm} to 2^{mm} broad. Head hemispherical, compressed, 0.35^{mm} broad by 0.25^{mm} long; suckers oval, 0.14^{mm} long by 0.13^{mm} (posterior) to 0.06^{mm} (anterior) broad; rostellum long, thick, cylindrical, 0.26^{mm} by 0.05^{mm}, armed on anterior end with simple crown of 8 hooks 57 μ to 60 μ long, roots of about equal length. Neck very long, much thinner than the head. Segments much broader than long; anterior segments 5 times as broad as long; posterior segments 3 times as broad as long, and somewhat funnel shaped; segments become 0.25^{mm} thick; thickness especially in the median line, which is traversed by a dark longitudinal band; thinner and more transparent toward the border; straighter at the angles, the strobila having a crenate appearance. Genital pores unilateral in anterior half of margin. Calcareous bodies absent from the head, but present in the neck and increase distally. *Male organs* begin to develop in ca. one hundred and twentieth segment; 3 testicles present in distal portion of segment, one median, two lateral; vas deferens runs diagonally toward proximal aporose corner of segment, swelling into a vesicula seminalis; near lateral margin it turns, runs parallel to anterior margin and leads to cirrus pouch, which also runs parallel to anterior margin of segment; cirrus pouch lies on aporose side of median line and contains a second vesicula seminalis, which communicates with a very long cirrus; genital cloaca 0.2^{mm} to 0.3^{mm} long by 0.03^{mm} to 0.09^{mm} broad, the broader portion being next to genital pore; a row of spines at the point where the penis opens into the cloaca; penis covered with minute spines. *Female organs* not well understood; begin in ca. one hundred and forty-fifth segment; a median oval body and two lateral lobed bodies joined together;

a median receptaculum seminis runs cephalad and diagonally, continues as vagina, which runs parallel to anterior margin nearly entire breadth of segment, and opens into cloaca near cirrus; a second larger lobed body = ? uterus.

Development: *Cercocystis Dr. fasciatæ* in *Cyclops agilis*, recorded by Mrázek.

Hosts: White-fronted goose (*Anser albifrons*); graylag goose (*A. anser*); tame goose (*A. anser dom.*).

Geographical distribution: Denmark (by Krabbe); Germany (by Feuereisen); Bohemia (by Mrázek).

Zeder referred a tapeworm which he had found in a goose to *T. crenata* Goeze, which was reported from *Picus major* (see Krabbe, 1869, p. 300). Rudolphi (1810, pp. 139–140) renamed the species *fasciata*, but does not appear to have examined it. Feuereisen (1868, pp. 162–190) then determined von Siebold's *T. fasciata* Rud. as *T. setigera* Frölich, 1789, and the year following Krabbe (1869, p. 300), stating that it was impossible to recognize definitely what goose tapeworm was included under the specific name *fasciata* by earlier authors, proposed to apply the name to a worm in geese provided with 8 hooks on the rostellum. Authors have since Krabbe's time adopted his form as *fasciata*. I retain this name provisionally, although it has no right to stand.

Mrázek (1890, 1891) records a cysticercoid from *Cypris agilis* which he identifies as the larval stage of *Tænia fasciata* Rudolphi. He evidently made no infections.

12. **Drepanidotænia gracilis** ([?Zeder, 1803] Krabbe, 1869) Railliet, 1893.

(1869, *Tænia gracilis* Krabbe.)

(? 1782, *Tænia collo longissimo* Bloch; ? 1803, *Halysis gracilis* Zeder; ? 1810, *T. gracilis* (Zeder) Rud.)

[Pl. VII, figs. 80–91; Pl. VIII, figs. 92–99.]

Diagnosis: About 270^{mm} long by 1.5–2^{mm} broad. Head subglobular; rostellum cylindrical, obtuse, armed with a simple crown of 8 hooks 77–80 μ long (95 μ and even 103 μ after Lönnberg). Neck very short. Anterior portion of body very thin for a considerable length; anterior segments infundibuliform, the following segments gradually becoming quadrate, genital pores unilateral. Receptaculum seminis pyriform; penis unarmed; genital sinus provided with large spines.

Development: *Cercocystis Dr. gracilis* in *Candona rostrata* by Scott, in *Cypris compressa* Baird (*Cypria ophthalmica* Jurine) and *Cyclops viridis* Fischer by Mrázek, in *Cypria ophthalmica* by Moniez.

Hosts: Tame duck (*Anas boschas dom.*); mallard duck (*A. boschas*); widgeon (*Anas penelope*); tame goose (*Anser anser dom.*); goosander (*Merganser merganser*); red-breasted merganser (*Merganser serrator*); common sheldrake (*Tadorna tadorna*).

Geographical distribution: Denmark, Germany. No epidemics recorded.

It is impossible to tell what worm was referred to under the specific term *gracilis* before Krabbe's time; the earlier descriptions may therefore be ignored for the present, the names being accepted as unidentifiable synonyms; it is impossible to show that the earlier worms were not identical with Krabbe's form from *Anas boschas dom.* The only positively known host for the adult up to Krabbe's time is, therefore, the tame duck.

Von Linstow (1872A, pp. 535–537) afterwards found a worm in the goosander (*Merganser merganser* [*Mergus merganser*]) which he identified with Krabbe's species. Lönnberg (1889, pp. 9–10, fig. 1) found a worm in *Tadorna vulpanser* which he described as a new variety: *T. gracilis* forma *Tadornæ*. The hooks on this worm were much larger than those of the type specimen, a variation which Lönnberg explains as due to host influence. Lönnberg (1890, pp. 10, 30) also records this form for *Mergus serrator* (= *Merganser serrator*).

Von Linstow (1872 A, pp. 535–537) found a cysticercoid measuring 0.14 by 0.09^{mm} in intestine of a perch (*Perca fluviatilis*), which he looked upon as the young of *Tænia gracilis*. The larva has also been found in certain fresh-water crustaceans which probably represent the regular intermediate host. Thus Scott (1891, p. 314) noticed an object in a mounted slide of *Candona rostrata* Brady & Norman, from the Edinburg district; Blanchard (1891A, pp. 330–332) examined Scott's preparation from *Candona rostrata*, and after a careful comparison of the hooks of the cysticercoid concluded that this larva belonged in the life cycle of *Tænia gracilis*. He explains von Linstow's finding this same larva in a perch by the fact that the fish had eaten some ostracodes. He introduces the formula—the length $= a - c$, the base $= a - b$, in measuring the hooks, using it as follows: For *T. gracilis* $ab : ac = 30$–75. Mrázek (1891, p. 128) cites the larva for *Cypris compressa* Baird and *Cyclops viridis* Fisch, while Moniez (1891, p. 26) mentions it from *Cypria ophthalmica* from China.

The larva referred to is in all probability the true larva of this species, but no infections have as yet been made.

b. **Rostellum with 10 hooks.**

13. **Drepanidotænia anatina** (Krabbe, 1869) Railliet, 1893.

(1869, *Tænia anatina* Krabbe.)

[Pl. IX, figs. 100–111; Pl. X, figs. 112–115.]

Diagnosis: Strobila attains 200^{mm} to 300^{mm} in length and 2^{mm} to 3^{mm} in breadth; worm of 70^{mm} in length has about 650 segments; number of segments in longest worms probably reaches 2,000. Head with a simple crown of 10 hooks 65 μ–72 μ long. Neck long. Fully matured segments half as thick as broad. Genital pores unilateral; copulation begins with about the five hundredth segment, uterus appears ca. 70 segments later. *Male organs:* Testicles 3 in number, one on pore side, two on aporose side of segment; cirrus pouch dorsal of vagina, elongate, extending to or slightly beyond the longitudinal canals, and possessing vesicula seminalis in its proximal portion; vas deferens swollen to an elongate vesicula seminalis near the pore-side testicle. *Female organs:* Vagina slightly longer than cirrus pouch, swelling into an enormous receptaculum seminis ventral of pore-side testicle; ovary large, about in median line; vitellogene gland distal of ovary; shell gland very small, dorso-proximal of vitellogene gland; uterus transverse, extending beyond longitudinal canals into the lateral field. Ova very characteristic; elongate 125 μ–175 μ by 90 μ with 3 shells; external shell thin and transparent, inner shell slightly constricted at lateral borders of the oncosphere; oncosphere elongate, 50 μ–60 μ, hooks 10 μ–11 μ. Dorsal canal small, dorsal of ventral canal; genital canals pass dorsally of dorsal and ventral canals.

Larval stage: Cysticercoid develops in small mussel crabs (*Cypris incongruens* Ramd.; *Cypris ovata; Cypris compressa*), and consists of three portions: (1) Scolex with (*a*) armed rostellum and 2 rostellum sacs, (*b*) four suckers provided with very minute cuticular hooklets (Schmidt), and (*c*) long, narrow neck provided with 30–40 calcareous corpuscles; (2) a hollow cyst or sac, composed of three layers; (3) a long, thin tail, in which the 6 hooks of the oncosphere are visible. The excretory system can be traced from the suckers to the end of the tail, where it ends in a terminal vesicle. Extended, the entire body may measure ca. 2^{mm}, the tail being 3½ to 4 times as long as the cyst. The scolex is contracted into the cyst, which then measures 0.19^{mm} to 0.20^{mm} by 0.21^{mm} to 0.23^{mm}, tail 0.7^{mm} to 0.8^{mm}.

Host: Domesticated duck (*Anas boschas dom.*); mallard (*A. boschas*); pintail (*Dafila acuta*).

Geographical distribution: Pomerania, by Croplin; Zealand (Denmark), by Gad and Krabbe; Schleswig, by Friis; France, by Moniez; Germany, by Schmidt. No epidemics recorded.

Krabbe (1869, pp. 287–288) found some specimens in Creplin's collections under the label *Tænia lævis* Bloch, collected from tame ducks. These worms agreed with others of Creplin's collection labeled *sinuosa*, from the same host, and with a third lot of worms from Gurlt's collection labeled "*Tænia porposa? Anas boschas fera,*" the latter being in a bottle with others which appeared to be *T. rhomboidea*. Friis found the same worm in wild ducks in Schleswig, and Gad and Krabbe found it in tame ducks in Zealand. The worm was found three times in 100 tame ducks. Krabbe (1882, p. 353) states that Professor Reinhardt found this same species in 1874 in *Anas acuta* [=*Dafila acuta*] taken in Zealand.

Mrázek (1891, pp. 110–113) describes a cysticercoid which he found in Bohemia in *Cypris incongruens* and *Cypris compressa* Baird (according to Moniez, 1891, *Cypria ophthalmica*); the larva measured 0.40^{mm} to 0.43^{mm}, and bore 10 hooks 65 μ long; the tail was very long; embryonic hooks measured 10 μ. Moniez (1891, p. 26) states that he found the same larva in *Cypris incongruens* at Lille, France, and that the species *T. anatina* is the most common tapeworm of domesticated ducks of that country.

It is to J. E. Schmidt (1894) that we owe our chief knowledge of this worm and the experimental demonstration of its life history. Schmidt infected numerous small 2.25^{mm} to 2.75^{mm} fresh-water crustaceans (*Cypris ovata*) with the eggs of adult animals taken from ducks, and followed the development in all its stages. He found that the ova are eaten by *Cypris;* the embryo escapes from its shells and passes into the body cavity of the intermediate host; here it grows into a roundish hollow ball which gradually elongates and develops the various organs of the cysticercoid; when the organs are formed, the larva retracts its scolex into its cyst. In summer the entire development of the cysticercoid lasts but two weeks, while in winter it lasts over five weeks.

Ducks naturally become infected by swallowing the mussel crabs.

14. **Drepanidotænia sinuosa** (Zeder, 1800) Railliet, 1893.

(1782, *Tænia collari nigro* Bloch—vide Rud., 1810; 1782, *T. infundibuliformis* (Anserum) Goeze—vide Dies., 1850; 1786, *T. collaris* Batsch—vide Rud., 1810; 1790, *T. torquata* Gmelin—vide Rud., 1810; 1800, *Alyselminthus sinuosus* Zeder; 1800, *Tænia breviarticulata* Goeze; 1803, *Halysis sinuosa* (Zeder, 1800) Zeder; 1803, *H. torquata* (Gmelin, 1790) Zeder—vide Rud., 1810; 1858, *Hymenolepis* (*Lepidotrias*) *sinuosa* (Zeder, 1800) Weinland).

[Pl. X, figs. 116–124; Pl. XI, figs. 125–139; Pl. XII, figs. 140–146; Pl. XIII, fig. 153.]

Diagnosis: 50^{mm} to 160^{mm} long by 1^{mm} to 2^{mm} broad. Head almost globular, rostellum armed with a simple row of 10 hooks 51 μ to 61 μ long. Neck very long. Anterior segments of variable breadth and length; the following segments trapezoidal; posterior segments rounded. Genital pores unilateral, situated toward the anterior third of the lateral margin; in each pore is found a globular sac, armed with spines, and appearing as a black point; this punctate line allows an immediate determination of the species. Eggs with 3 envelopes, the exterior 42 μ to 44 μ; hooks of oncosphere 7 μ to 8 μ.

Development: Cercocystis Dr. sinuosæ found in *Gammarus pulex* by Hamann and von Linstow; in *Cyclops viridis* Fisch, *C. agilis* Koch and *C. lucidulus* Koch, by Mrázek.

Hosts: Tame ducks (*Anas boschas dom.*); mallard duck (*A. boschas*); Brazilian teal (*A. braziliensis*); tame goose (*Anser anser dom.*); graylag goose (*A. anser*); pintail (*Dafila acuta*); tufted duck (*Aythya fuligula*).

Geographical distribution: France, Germany, Italy, Sweden, and Bohemia.

The species *sinuosa* as at present adopted by authors stands on a most peculiar footing.

Goeze left a description and figures of this worm, with the MS. name *Tænia breviarticulata*, from *Anas fusca*, which were later published by Zeder (1800, pp. 295–298) under *Alyselminthus sinuosus*. According to Krabbe (1869, p. 298) Rudolphi determined as *sinuosa* forms which differ greatly from one another. Dujardin (1845, p. 573) then gave a more exact description of a form which he determined as *T. sinuosa* (Zeder) Rud., taken from *Anas acuta*, adopting Rudolphi's synonymy in all essentials. Krabbe (1869, pp. 298–299) adopted Dujardin's determination of Zeder-Rudolphi's species, but ignored synonymy prior to Zeder. Thus we have no way of knowing whether the form now named *sinuosa* is identical with the original *sinuosa* or not, and Dujardin is the earliest author to whom we can trace the present *sinuosa* with any degree of certainty. Authors generally follow Krabbe in accepting Dujardin's determination of Zeder's *sinuosa* and it will be well at present to adopt this plan.

The views concerning the life history of this worm rest upon observations by Hamann, Mrázek, and von Linstow. Hamann (1889, pp. 1–7, Taf. I) found some cysticercoids in *Gammarus pulex* which von Linstow determined as the young of *T. sinuosa*. They were oval to spherical; tail surrounds body as a yellowish border; 6 oncospheric hooks, 13 μ long, persistent, one pair at end, one in middle, and one at beginning of tail; tail 0.5^{mm}, body with tail 1.3^{mm} long; hooks of cysticercoid 50 μ long, 10 in number; calcareous bodies numerous, 6 μ in diameter, oval. Mrázek found a cysticercoid in Bohemia, 0.23^{mm} long; tail moderately long, oncospheric hooks 11 μ; 50 calcareous corpuscles present. He identified this organism with Hamann's larval form, and records it from *Cyclops viridis* Fisch, *C. agilis* Koch, and *C. lucidulus* Koch. So far as I can learn no infections were made with these parasites.

15. **Drepanidotænia setigera** (Frölich, 1789) Railliet, 1893.

(1789, *Tænia setigera* Frölich; 1800, *Alyselminthus setigerus* (Frölich, 1789) Zeder; 1803, *Halysis setigera* (Frölich, 1789) Zeder; 1819, "*Tænia sinuosa* Rud.," 1810, of Rud., pars.—vide Krabbe, 1869; 1848, "*T. setigera* Frölich," 1789, of Siebold; 1858, "*T. fasciata* Rud.," 1810, of Feuereisen; 1869, "*T. setigera* Frölich" of Krabbe.)

[Pl. XII, figs. 147–150; Pl. XIII, figs. 154–164.]

Diagnosis: Strobila 200^{mm} long by 1^{mm} to 3^{mm} broad. Head subglobular, 0.24^{mm} long by 0.28^{mm} to 0.33^{mm} broad; rostellum with simple crown of 10 hooks 35 μ to 43 μ (40 μ to 60 μ long, prong 20 μ long, roots 20 μ apart, after Feuereisen); ventral root short and plump, dorsal root longer. Suckers rather large, elliptical. Neck, 0.59^{mm} long by 1.16^{mm} broad. (Segments very short, 10 times as broad as long, Feuereisen.) Anterior segments very short, the following slightly longer, funnel shaped, with very prominent posterior angles; chain traversed by a dark median band. Pores unilateral, small, situated toward anterior angle of the segment, frequently with extruding penis. Genital organs begin with eight hundred and thirtieth segments; embryos begin with one thousand five hundredth segment. Calcareous bodies less numerous than in *Dr. fasciata*. *Male organs:* Male maturity is reached about the one thousand and thirtieth segment and is continued about 100 segments. Testicles three, 13 μ in diameter, posterior; an uncertain body (probably vesicula seminalis) lateral but near median line; vas deferens parallel and near anterior margin; cirrus pouch 0.35^{mm} long, more than half as broad as the younger segments, parallel to and near anterior margin, 39 μ (median portion) 19 μ (lateral portion) broad; broadest part is 160 μ to 190 μ long and contains a vesicula seminalis 0.1^{mm} to 0.15^{mm} long by 30 μ broad; penis covered with minute spines. *Female organs:* Very imperfectly understood. A body appears on aporose side of median line, develops and divides into two pyriform bodies, which remain connected (=ovary?); from their point of juncture a canal runs toward the genital pore, and shows two swellings, a median (? receptaculum seminis) and a lateral (? receptaculum seminis); an oval body (= ? ovary) appears in the extreme aporose side of the segment, and from this extends another body (uterus) toward the median line, increasing in size as the (?) ovaries decrease. Oncospheres 19 μ, hooks 7.9 μ.

Development: *Cercocystis Dr. setigeræ* in *Cyclops brevicaudatus* Claus, found by Schmeil.

Hosts: Tame goose (*Anser anser dom.*); white-fronted goose (*A. albifrons*); bean goose (*A. fabalis*); barnacle goose (*Branta leucopsis*); tame swan (*Olor cygnus dom.*) cited by von Linstow, but Railliet believes this erroneous; whooping swan (*Olor cygnus*).

Geographical distribution: Germany, France, Denmark, Sweden, and Ireland. Lucet found it producing a serious epidemic among the young geese in Loiret (Railliet, 1893, p. 301).

The name *Tænia setigera* was proposed by Frölich (1789, pp. 106–111) for a worm 3 feet long and 3 lines broad, with unilateral genital pores, which he found in pastured geese. He states that the rostellum is unarmed; the form is, like many earlier species, not well described, and the figures are poor, so that it is not possible to tell with absolute certainty what species Frölich examined. Bellingham (1844, p. 320) records it for Ireland. Von Siebold (1848, p. 131) states that in this species he found 10 hooks on the rostellum. There is no way of proving that Siebold's worm was Frölich's *setigera;* at the same time, as there is no way of disproving it, we may as well accept von Siebold's statement regarding the hooks; the species *setigera* accordingly would rest upon this character. Feuereisen (1868, pp. 190–200) described the anatomy of a goose tapeworm, determined as *T. fasciata* Rud., which possessed 10 hooks and is probably identical with von Siebold's *T. setigera* Frölich. In 1865 and 1868 Krabbe (1869, pp. 289–290) examined 400 geese and found *T. lanceolata* present in 77 of them, and another tapeworm 9 times which possessed 10 hooks on the rostellum: this latter worm Krabbe determined as *T. setigera.* Krabbe also examined specimens from Rudolphi's collection (see Rud., 1819, p. 700) collected by Brosche in Dresden, and determined by Rudolphi as *T. sinuosa;* these worms were "undoubtedly identical with" *T. setigera.* Lönnberg (1889, p. 8) records this species for *Anser segetum* (new host) in Kristineberg; he also includes the white-fronted goose (*Anser albifrons*) among the hosts, but does not state his authority. Railliet (1893, p. 301) placed *T. setigera* in his genus *Drepanidotænia.* Von Linstow (1892B, pp. 503–504) states that Dr. O. Schmeil found in *Cyclops brevicaudatus* a globular cysticercoid 0.133^{mm} in diameter, with a thin, long (2.14^{mm}) tail, 10 hooks 39 μ, on the rostellum, which von Linstow identifies as the young of *T. setigera.* No infections were made. The life history as given above is, therefore, theoretical though probable.

16. **Tænia Krabbei** Kowalewski, 1895 [nec Moniez, 1879]. [Sp. dub.]

(1894, *Tænia Krabbei* Kowalewski [nomen nudum].)

[Pl. XII, figs. 151–152.]

Krabbe (1860, p. 290) states that he once found in the intestine of a domesticated goose a tapeworm head with 10 hooks similar in form to those of *Drepanidotænia setigera* but much smaller, i. e., 24 μ long. He thought that perhaps it belonged to another form, but figured the hooks as "*T. setigera?;*" the hooks, as well as the head, bore a great resemblance to *Drepanidotænia tenuirostris.* He also found a few heads with 10 similar hooks in the domesticated duck; the hooks were 28 μ long. Kowalewski (1894, p. 5), in a paper which I am unable to read because of the language, mentioned this worm as a new species under the name *Tænia Krabbei.* In a second paper (1895, p. 359, Taf. VIII, fig. 27), he gives a short discussion of the worm, and figures 2 hooks. In the German resumé (1894, p. 279) of this paper he simply states: "A species from the goose which was already found by Krabbe, but not described, is proposed as a new species (*Tænia Krabbei*) and its external characters are discussed."

The status of this species can not be judged at present, but the slight variation in the form of the hooks is not, in my opinion, sufficient to establish the form. As Kowalewski has unfortunately written in a language which is not understood by many authors, it is difficult to judge his work, and as it is now necessary for an investigating helminthologist to learn no less than ten languages in order to keep up with his branch, it is to be hoped that Kowalewski will in the future give full translations of his scientific articles in German, French, English, Italian, or some other language better known than his own.

Whatever may prove to be the status of this species, the name *T. Krabbei* can not be retained for it, as this name has always been used by Moniez for another form.

17. **Drepanidotænia tenuirostris** (Rudolphi, 1819) Railliet, 1893.

(1819, *Tænia tenuirostris* Rudolphi.)

[Pl. XIV, figs. 165–172.]

Diagnosis: 100^{mm} to 125^{mm} long, 1^{mm} to 3^{mm} broad. Head subglobular; rostellum delicate, subclaviform, armed with a single crown of 10 hooks 20 μ to 23 μ long; suckers round Neck rather long. Anterior segments straight and short, the following longer, with sharp prominent posterior angles, like the teeth of a saw. Genital pores unilateral. Egg cylindrical, 85 μ long. Hooks of oncosphere 7 μ.

Development: Cercocystis Dr. tenuirostris in *Gammarus pulex,* found by Hamann and von Linstow; in *Cyclops agilis* and *C. pulchellus* found by Mrázek.

Hosts: Tame goose (*Anser anser dom.*); European scaup duck (*Aythya marila*); tufted duck (*Aythya cristata*); goosander (*Merganser merganser*); red-breasted merganser (*M. serrator*); smew or nun (*Mergus albellus*); Greenland eider (*Somateria mollissima*); velvet scoter (*Oidemia fusca*); kittiwake (*Rissa tridactyla*).

Geographical distribution: Denmark, France, Germany, and Bohemia. No epidemics recorded.

Krabbe (1869, pp. 291–292) examined Rudolphi's types and found hooks upon the rostellum, although they had escaped Rudolphi's attention. The original specimens were collected by Bremser from *Merganser merganser;* von Siebold also found this species in the same host in Bavaria and Krabbe found the same worm in *Aythya marila.* It is also reported from other wild birds. Bellingham (1844, p. 320) gives *Aythya cristata* as a host, but does not state his authority.

Hamann (1889, pp. 7–9, figs. *a–c*) found a cysticercoid in *Gammarus pulex* which he looks upon as the larval stage of this worm, and he assumes that as the domestic duck is the only bird (i. e., so far as Hamann knows) which visits the water in which this larval stage was found, this tapeworm is also found in domesticated ducks. An argument like this has value in science only in order to place us on our guard for the parasite, but it would be going altogether too far to accept this worm as a parasite of domesticated ducks until it is found in that host. Hamann made no infections with his larval form, and accordingly the demonstration that this cysticercoid represents the larval stage of *Dr. tenuirostris* is still lacking. Hamann describes the larva as lying in a cyst fastened to the intestine of the crustacean, and possessing a yellowish tail and grayish-white body; diameter 0.2^{mm}, hooks 10 in number, 23 μ long; calcareous bodies oval 6 μ, oncospheric hooks 9 μ. Von Linstow (1892A, pp. 338–339) observed the same larva in the same host, and Mrázek (1891, pp. 101–103, 126–129) describes it from *Cyclops agilis* and *Cycl. pulchellus* in Bohemia. His specimens were very small 0.10^{mm} to 0.11^{mm}; 10 hooks 21 μ to 23 μ; tail long; oncospheric hooks 8 μ.

B. Genital pores irregularly alternate.

18. **Drepanidotænia infundibuliformis** (Goeze, 1782) Railliet, 1893.

(1772, *Globus stercoreus* Scopoli—vide Parona, 1894; 1779, *Tænia infundibulum* Bloch—vide Goeze, 1782; 1781, *T. avium* Pallas—vide Goeze, 1782; 1782, *T. articulis convideis* Bloch—vide Rud., 1810; 1782, *T. infundibuliformis* Goeze; 1786, *T. cuneata* Batsch [nec Linstow, 1872]—vide Rud., 1810; 1788, *T. conoidea* Schrank—vide Rud., 1810; 1794, *T. serrata* Rosa [nec Goeze, 1782]—vide Parona, 1894; 1800, *Alyselminthus infundibuliformis* (Goeze) Zeder; 1803, *Halysis infundibuliformis* (Goeze) Zeder.

[Pl. XIV, figs. 173–186; Pl. XV, figs. 187–193.]

Diagnosis: 20^{mm} to 130^{mm}, rarely 230^{mm} long. Head globular, rather depressed; rostellum elongate, cylindrical, or hemispherical, swollen at summit, armed with a single row of 16–20 hooks 20 μ to 27 μ long, with long dorsal and short ventral root; suckers rather small. Neck very short. Anterior segments very short, the following funnel shaped, the anterior border being much narrower than the posterior border; posterior segments almost as long as broad. Genital pores irregularly alternate. Penis thick, covered with few spines. Hooks of embryo 12 μ to 17 μ. (See also diagnosis given below, p. 44.)

Development: According to Grassi & Rovelli the cysticercoid develops in the ordinary house fly.

Hosts: Chickens (*Gallus domesticus*); migratory quail (*Coturnix coturnix*); ? pheasants (*Phasianus colchicus*); mallard (*Anas boschas*); tame duck (*Anas boschas dom.*); ?crowned pigeon (*Goura* sp.); ? domesticated pigeon (*Columba livia dom.*); sparrow (*Fringilla domestica*).

Geographical distribution: France, Italy, Ireland, Zealand (Denmark) (Krabbe), Pomerania (Creplin), and Saxony (Küchenmeister). No epidemics.

The earlier descriptions of *Dr. infundibuliformis* are exceedingly unsatisfactory, and in many cases it is impossible to recognize what species an author had before him when he determined it as *infundibuliformis.*

Krabbe (1869, pp. 339–341) examined Rudolphi's (1810) specimens and determined the forms from chickens as "undoubtedly identical" with specimens which he collected in Zealand, and with specimens from Creplin's and Küchenmeister's collections. Rudolphi's (1810, p. 124) specimens from *Otis tarda*, however, Krabbe determined as different from the specimens from chickens.

This seems to be the earliest exact reference to this species, which, therefore, rests upon Krabbe's (1869) study of the material which Rudolphi (1810, pp. 123–126) determined as Goeze's (1782, pp. 386–390) *Tænia infundibuliformis.* Unless original specimens of authors before Rudolphi can be studied again, and unless it can be shown by this means that Rudolphi's (1810) specimens were not really identical with Goeze's *infundibuliformis*, this specific name may at present be applied to the parasites as determined by Krabbe. It is useless to revert to the names prior to *infundibuliformis*, 1782, unless the originals upon which those names were based can be restudied. Bellingham (1844, p. 319) records this species for *Anas boschas, A. boschas dom.*, and *Fringilla domestica.* The form which Dujardin (1845, p. 586) determined as *infundibuliformis* is referred to *Davainea cesticillus.* Krabbe found this worm (*Dr. inf.*) in 26 out of 200 chickens in the region of Copenhagen. Mégnin (1881A, pp. 33–35) states that he found *T. infundibuliformis* in large numbers in the epidemics of syngamosis among pheasants, but it is evident that the form he referred to was his *T. agama.* Bremser also records it from pheasants, but his observation should be confirmed. Mégnin records it for pigeons and in *Goura*, but these observations also need confirmation, for Mégnin remarks that the specimen from *Goura* had three rows of hooks upon the suckers, (? *Davainea cesticillus*, q. v. p. 48). Piana (1882, p. 392) found this parasite the most common tapeworm of chickens. Grassi & Rovelli (1889, p. 404; 1892, pp. 33–34, 89) state that they found the larval stage in the house fly (*Musca domestica*), but they did not prove their point experimentally. Crety (1890, pp. 5–8) records *Coturnix communis* as a new host, and remarks upon the anatomy of the parasite. Unfortunately the figures are unsatisfactory, and the description is, therefore, not of such value as it otherwise would be; from his description the following characters are taken:

Diagnosis: (*T. infundibuliformis*) Strobila to 100^{mm}. Head very small, spheroidal, 0.387^{mm} broad; rostellum armed with 20 hooks upon its cupola-like extremity; length of rostellum 0.137^{mm}, breadth 62 μ to 75 μ; hooks 23 μ long; suckers 0.215^{mm} by 0.156^{mm}. Neck very short, 0.313^{mm} in length; middle segments 0.48^{mm} long, posterior segments 0.901^{mm} long. Genital pores ———. *Male genitalia:* Testicles 16 to 20 in number, 29 μ to 44 μ in diameter, situated in median field; vas deferens begins about the middle of the segment, first portion slightly sinuous, lateral portion very tortuous; cirrus pouch globose, 71 μ in diameter; cirrus armed with numerous small spines. *Female genitalia:* Receptaculum seminis 106 μ by 39 μ, situated near the ovary; ovary globose, near anterior margin, occasionally irregularly divided into two halves; oviduct runs from ovary, in median line, distally; vitellogene gland in about the middle of the proglottid is generally globose, occasionally irregularly divided into two portions, vitello-duct runs cephalad from its median portion; shell gland very small, between ovary and vitellogene gland; uterus forms very quickly, in the mature proglottid it occupies the entire median field and is composed of a large cavity imperfectly divided into numerous small cells (=egg capsules?). Ova 55 μ by 46 μ, with 3 shells; oncosphere 33 μ, hooks 17 μ. (Krabbe: hooks 12 μ to 17 μ.)

Pasquale (1890, p. 909) records the worm for chickens in Massowah. Ralliet (1893, p. 302) well remarks that the generic position of this species is doubtful. (See addendum, p. 61.)

I refrain from discussing this form further, except to remark that practically nothing is definitely known about the species. Crety's description is the only one which can be given the dignity of a diagnosis, and yet that was not based upon originals. The earlier descriptions, which take no account of the internal anatomy of the segments, are almost useless so far as zoological descriptions are concerned. Were it not for the fact that the original host (chickens) is known, I have the most serious doubt whether it would ever be possible to recognize this form; and whether even the numerous specimens recorded from chickens as *T. infundibuliformis* are to be considered as such is, in my opinion, an open question. I have specimens of worms from pigeons (*Columba domestica*) and from turkeys (*Meleagris gallopavo mexicana*), which I should like to determine as *Dr. infundibuliformis*, but it seems to me that this specific name, like *Tænia expansa* of older authors, is only a Latinized form of expressing one's doubts or ignorance as to what species is in the hands of a given worker, while as for the supposed life history, with the fly as intermediate host, although I am not willing to deny the correctness of the hypothesis, I do insist that it is only an hypothesis, with little back of it, and that it is now time to call a halt on such speculative work and to distinguish between what is shown experimentally to be fact, and what might possibly be shown to be fact. (See also *Tænia nigropunctata.*)

B. Suckers armed: genera *Davainea*, *Echinocotyle*, and *Ophryocoytle*.

Genus **DAVAINEA** R. Blanchard & Railliet, 1891.

(? 1893, *Chapmania* Monticelli.)

Diagnosis: Worms of small or medium size. Head rounded, surmounted by a rostellum or hollowed by a depression, but armed in either case with a double row of numerous small hooks possessing a special form (prong and dorsal root short, ventral root very long, giving them the form of a hammer). Suckers rounded, bordered with several rows of small hooks which are instable or persistent. Genital pores generally unilateral but occasionally irregularly alternate; in the former case (unilateral pores), the ova are generally arranged in groups, in egg capsules; ovary in some species develops into the uterus; eggs also isolated, scattered through the parenchyma; embryos without pyriform body.

Type species: As the type species has evidently never been proposed, I propose *D. proglottina* (Davaine, 1860) R. Blanchard, 1891, as type.

Development: As yet little known; the larvæ of some species, however, have been found in certain arthropods and mollusks.

Habitat: Intestine of birds and mammals.

Blanchard (1891B, pp. 428–440) recognizes fourteen species as belonging to this genus, and thinks that *T. cantaniana* and *T. clavulus* may also be placed here. Some of the forms Blanchard includes here are well established, others rest upon weak characters.

Monticelli (1893, pp. 16–17) has recently proposed a new genus *Chapmania* which seems to be very closely related to, if not identical with *Davainea.* His diagnosis reads as follows:

> Head rounded, small, with a protractile anterior sucker armed on its anterior margin with a crown of very minute hooklets. Suckers rather large, unarmed. Proglottids campanulate. Genital pores unilateral. Testicle single. Ovary bilobed, dendritic.

Monticelli took Zschokke's (1888, pp. 2–6, 41–46) *Tænia argentina* as basis for his genus, and considered this species identical with Chapman's *Tænia tauricollis.* In this latter point Monticelli is probably in error, while as for the genus, it certainly rests upon too weak characters to be recognized at present. The "anterior sucker" is, of course, the invaginated rostellum and sac; the only valuable character remaining is the single testicle. The bilobed dendritic ovary, the form of the segments, etc., must all be rejected as generic characters.

The exact status of the genus and the ? one or ? two species (*tauricollis* and *argentina*) must be left undecided for the present.

1.	Genital pores alternate	2
	Genital pores generally unilateral, occasionally alternate; rostellum with about 200 hooks 6 μ long	*D. tetragona,* p. 49
	Genital pores unilateral	4
2.	Segments not over 5 in number; strobila 1.5^{mm} long or less; rostellum with about 80 hooks 7 μ long; found in chickens	*D. proglottina,* p. 47
	Segments numerous, and strobila much longer than 1.5^{mm}	3
3.	Rostellum with about 100 hooks 8 μ long; found in chickens and (?) pigeons	*D. echinobothrida,* p. 49
	Rostellum with 208 hooks 7 μ to 8 μ long; found in chickens	*D. cesticillus,* p. 48
	Rostellum with about 800 hooks 11 μ long; found in quails	*D. circumvallata,* p. 47
4.	Rostellum with 150 hooks 12.8 μ long; found in pheasants	*D. Friedbergeri,* p. 52
	Rostellum with ca. 60 hooks 11 μ long; found in pigeons and (?) ducks	*D. crassula,* p. 53

a. Genital pores irregularly alternate.

19. Davainea proglottina (Davaine, 1860) R. Blanchard, 1891.

(1860, *Tænia proglottina* Davaine; 1881, "*T. proglottidina* Dav." of Piana.)

[Pl. XV, figs. 194–198; Pl. XVI, figs. 199–202.]

Diagnosis: 0.5^{mm} to 1.55^{mm} long by 0.18^{mm} to 0.50^{mm} broad. Head club shape to quadrangular, 140 μ to 250 μ long by 135 μ to 200 μ broad, rather rounded in front and slightly constricted in back to form neck (108 μ broad); apex armed with retractile hemispherical rostellum 55 μ in its antero-posterior diameter and 60 μ to 85 μ in its lateral diameter; base of rostellum armed with about 80–95 hooklets measuring 6.5 μ to 7.5 μ. Suckers circular, small (25 μ to 35 μ), armed with a single row of hooklets (6 μ), with rather large, bilobed base. Strobila composed of 2–5 segments, first segment only about 56 μ long, the following segments increasing in length and width. Genital pores irregularly alternate, situated at the anterior angle. The second segment possesses well-developed male organs and the anlagen of the female organs. In the third segment the testicles are atrophied, the female organs (median posterior vitellarium, two ovaries, recept. sem., vagina) well developed, but no uterus present. In the fourth segment all the genital glands are atrophied, and the segment is filled with numerous isolated eggs (not in egg capsules); ova 35 μ to 40 μ; hooks of oncosphere 10 μ to 11 μ. The segments have a great tendency to separate more or less completely; the last segment, after separating, remains in the intestine and grows to 2^{mm} long by 1.25^{mm} broad (larger than the entire worm).

Development: Larval stage is found in slugs (*Limax cinereus*, *L. agrestis*, and *L. variegatus*, and develops from the oncosphere in less than twenty days; fed to chickens, the cysticercoid becomes adult with 4 segments at the end of eight days.

Host: Chickens (*Gallus domesticus*).

Geographical distribution: France (Rennes by Dujardin), in le Nord by Davaine, in Loiret by Lucet, in Indre-et-Loire by R. Blanchard, and Italy by Grassi & Rovelli.

Epidemics: Lucet observed a serious epizootic enteritis in fowls produced by this parasite in Loiret (Railliet, 1893, p. 305).

The life history of this worm has been experimentally demonstrated and this is one of the few tapeworms of fowls which can be said to be comparatively well known from a scientific standpoint.

20. Davainea circumvallata (Krabbe, 1869) R. Blanchard, 1891.

(1819, *Tænia linea* Rud., pars; 1869, *T. circumvallata* Krabbe; 1890, *T. pluriuncinata* Crety.)

[Pl. XVI, figs, 203–211.]

Diagnosis: Strobila 40^{mm} to 150^{mm} long. Head pyriform 0.627^{mm} to 0.8^{mm} long by 0.598^{mm} to 0.65^{mm} broad. Rostellum armed with a double row of about 800 minute hooklets, of two different sizes, the larger and smaller alternating, the larger hooks 11 μ (Krabbe), 16 μ (Crety); smaller hooks 8 μ (Krabbe), 12 μ (Crety). In the earlier stages (see below *T. pluriuncinata*) the suckers are armed with 6–8 concentric rows of instable hooks which vary in size, but of similar form. Suckers small, 0.186^{mm} to 0.196^{mm} in diameter. Neck present, thin. Anterior segments 0.195^{mm} broad by 0.40^{mm} long (after Crety, 1890, p. 2, the figures should undoubtedly be reversed); middle segments 2^{mm} to 3^{mm} broad by 1^{mm} long; posterior segments 1.5^{mm} long by 2.5^{mm} broad. Genital pores irregularly alternate in about the middle of the lateral margin. *Male genitalia:* In posterior portion of segment; testicles 15–20 in number, 45 μ in diameter, distributed regularly in median field; the common vas deferens takes origin in about the middle of the segment, medium portion more or less simple, lateral portion convoluted; upon entering the cirrus pouch it swells into a vesicula seminalis, 53 μ long by 39 μ broad, distinct only in the younger segments; cirrus covered with extremely minute spines, visible only with an immersion lense. *Female genitalia:* In anterior portion of segment. Ovary median near anterior margin, at first transverse, in the older segments it becomes globose and occasionally irregularly divided into two lateral halves, connected by a median portion which leads into the oviduct; in middle proglottids transverse diameter of ovary 0.186^{mm}; oviduct short, runs distally; vitellogene gland distal of ovary, in youngest segments appears as a globular sac next to ovary, in older segments further removed from it and much smaller than it, occasionally divided; vitelloduct runs from middle of vitellogene gland proximally; shell gland very small, situated between ovary and vitellogene gland; vagina swells into a receptaculum seminis 58 μ by 39 μ near the ovary; uterus forms rapidly, suppresses genital glands, eggs arranged 4–6 or more in egg capsules. Ova 28 μ by 24 μ; hooks of oncosphere 11 μ to 17 μ (Krabbe), 3 μ to 4 μ (Crety), oncosphere 11 μ.

Type specimen: Berlin museum.

Life history: Unknown.

Hosts: Migratory quail (*Coturnix coturnix*) by Rudolphi and Crety; (*C. dactylisonans*) by Ninni [Stossich].

Geographical distribution: Italy, by Rudolphi, Crety, and Ninni.

Blanchard (1891B, p. 434) looks upon Crety's *Tænia pluriuncinata* as synonymous with *D. circumvallata.* Crety's description of *T. pluriuncinata* is as follows:

Diagnosis: Strobila up to 105^{mm} long. Head very small 0.313^{mm} broad. Rostellum armed with a double row of alternately larger and smaller hooks, the larger 8 μ, the smaller 5 μ long, in form very similar to those of *T. circumvallata;* suckers very small, 98 μ in diameter, armed with 6–8 concentric rows of hooks, the latter varying in size, but of similar form. Neck 2.5^{mm} long, thin. Young segments 0.323^{mm} broad by 0.2^{mm} long; middle segments trapezoid, 3^{mm} broad; posterior segments 2^{mm} broad by 1^{mm} long. Genital pores irregularly alternate; genital apparatus (very insufficiently described); cirrus pouch pyriform, 127 μ by 20 μ; ova in egg capsules same as in *T. circumvallata;* diameter of ova 22 μ by 16 μ; oncosphere 9 μ.

Host: Migratory quail (*Coturnix coturnix.*)

Whether Blanchard is correct in his opinion can be determined only by a comparison of specimens, but in the meantime one is bound to admit that *T. pluripunctata* can hardly be admitted as a species upon its present diagnosis.

21. Davainea cesticillus (Molin, 1858) R. Blanchard, 1891.

(1845, "*Tænia infundibuliformis* Goeze," 1782, of Dujardin; 1858, *T. cesticillus* Molin; 1881, *T. infundibuliformis* pars of Mégnin.)

[Pl. XVII, figs. 212–216.]

Diagnosis: Length, 9^{mm} to 45^{mm} (according to Molin), 100^{mm} to 130^{mm} (according to others). Head globular, 0.5^{mm} to 0.55^{mm} broad; rostellum convex or hemispherical, not prominent, 0.28^{mm} to 0.32^{mm} broad, armed with about 208 hooks 7 μ to 8.8 μ long, arranged in two rows; these hooks have a very short dorsal and a long ventral root; suckers 10 μ to 11 μ, not prominent. Neck very short (Duj.) neck absent (Railliet). Anterior segments 3–5 times as broad as long, being broader than the head, but very short; the following segments increasing gradually in size and becoming nearly as long as broad, borders overlapping. Genital pores irregularly alternate. Eggs elliptical 75 μ to 85 μ; hooks of oncosphere 16 μ to 17 μ (Railliet) 18 μ to 23 μ (Dujardin). Development unknown.

Host: Chickens.

Geographical distribution: France (by Dujardin); Italy (by Molin, Grassi, Rovelli); Denmark (by Krabbe); Turkestan (by Fedtschenko); Abyssinia (by Pasquale). Epidemics: None recorded.

Dujardin (1845, pp. 586, 609, Pl. IX, fig. H, 1-2) erroneously determined this worm as *T. infundibuliformis;* Molin (1858, p. 139) described it as *T. cesticillus.* Krabbe (1869, pp. 342-343) found it in 16 out of 200 chickens in Denmark, and mentions a somewhat similar worm from Siebold's collection, taken in Egypt by Bilharz. Piana (1882) records *T. cesticillus* in Italy and Pasquale (1890) says it is the most common form at Massowah (Abyssinia), where he in one instance took about 300 from one chicken. Grassi & Rovelli (1892, p. 88) suspect that the intermediate host is a lepidopteron (butterfly) or a coleopteron (beetle), but this is wild speculation. Stossich (1890A, p. 39; 1890B, p. 53) records the same species in two different publications, once as being collected in Venice by Ninni, and a second time as being rather rare in chickens in Trieste. Blanchard (1891B, p. 434) looks upon part of Mégnin's *T. infundibuliformis* as belonging here; the worm in question has, according to Mégnin (1881A, pp. 27-44) 3 rows of hooks on the suckers.

For Neumann's (1888 and 1892) combination *T. cesticillus* var. *phasianorum* which he attributes to Mégnin (1887, p. 828), vide p. 53 (*Tænia infundibuliformis* var. *phasianorum* Mégnin, 1887, p. 825 ff., under *T. Friedbergeri*).

22. **Davainea echinobothrida** (Mégnin, 1881) R. Blanchard, 1891.

(1880, *Tænia infundibuliformis* of Mégnin (pars); 1880, *T. echinobothrida* Mégnin, nomen nudum; 1881, *T. echinobothrida* Mégnin.)

[Pl. XVII, figs. 217-218.]

Diagnosis: 50^{mm} to 100^{mm} long, 1^{mm} to 4^{mm} broad. Head small, cuboid, its summit presenting an infundibulum armed with about 100 hooks, 8 μ long, arranged in a double row. Suckers large, armed with 7 circular rows of hooks, the hooks of the middle row being the largest; with age these hooks fall and the suckers gradually become indistinct. Neck nil. Anterior segments very thin, 50 times broader than thick; following segments increasing gradually in size, the posterior border overlapping, so that the margin of the strobila appears serrate. Eggs spherical, 90 μ in diameter, arranged in groups of 6-7 in roundish egg capsules. Development unknown.

Hosts: Chickens (Mégnin), ? pigeons (Mégnin—possible another species of worm according to Railliet), and ? pheasants (see Blanchard).

Geographical distribution: France by Mégnin. Epidemics: Mégnin states that this did not produce any serious effects in its hosts.

The types of this species should be compared with *D. tetragona* and *T. bothrioplitis,* as the worms are very similar, if not identical. The character of the genital pores as a specific difference I can hardly admit for this form. (See the discussion under *D. tetragona.*) Mégnin states that the hooks of the middle rows of the suckers are the largest and this, if the observation is confirmed, would separate the species from *T. bothrioplitis.*

b. Genital pores unilateral, occasionally alternate.

23. **Davainea tetragona** (Molin, 1858) R. Blanchard, 1891.

(1858, *Tænia tetragona* Molin; 1881, *T. bothrioplites* Piana (nomen nudum); 1882, *T. bothrioplitis* Piana.)

[Pl. XVII, figs. 219-227; Pl. XVIII, figs. 228-235.]

Diagnosis: 12^{mm} to 90^{mm} long (Molin) or to 200^{mm} (Piana) or to 250^{mm} (Krabbe), by 1.6^{mm} to 3^{mm} broad. Head small, tetragonal; retractile rostellum armed with a double row of about 200 hooks, 6 μ long. Suckers circular, armed with seven or eight concentric rows of hooks of varying size. Neck very long. Anterior segments very short; the following subquadrangular, the posterior edges overlapping.

Genital pores unilateral or irregularly alternate, situated in or about the middle of the margin. Eggs arranged irregularly in groups of 5–20 in egg capsules.

Development: According to Piana, the larval stage (*Monocercus Davaineæ tetragonæ*) develops in snails (*Helix carthusianella* or *H. maculosa*).

Hosts: Chickens.

Geographical distribution: Italy (by Molin, Piana), Turkestan (by Fedtschenko), Abyssinia (Pasquale), America (Washington, D. C., by Moore).

Epidemics: Italy by Piana; Washington, D. C., by Moore.

I include *T. bothrioplitis* in the species *D. tetragona* and retain *D. echinobothrida* as a distinct species, chiefly in deference to the opinion of my friends R. Blanchard and Railliet. Personally I do not see why the species *D. tetragona* should be recognized, or why two of these forms should be united while the third is kept distinct, for the descriptions of all three forms are incomplete, and, as will be shown in the following historical review, any arrangement of the three worms can be looked upon at present only as provisional. The historical review is given in detail, as these three (or one?) species represent very important parasites.

Molin (1858, p. 139) first described as *Tænia tetragona* some tapeworms which he found in chickens in Padua in December, 1857, as follows:

> Caput tetragonum, minimum, acetabulis quatuor angularibus, alveolo ad basim rostelli excavatum; rostellum inerme, brevissimum, obtuso-conicum, in alveolum retractile; collum breve; articuli supremi brevissimi; postremi subquadrati, imbricati; aperturæ genitales marginales, secundæ, in apice papillæ prominulæ. Longit. 0.012–0.090; lat. ad 0.002.
>
> Habitaculum. Phasianus Gallus: in intestino tenui, Decembri, Patavii (Molin).

Like most of Molin's descriptions, this diagnosis gives us but little information concerning the parasite he had before him. It should be noticed, however, that he (probably erroneously) describes the rostellum as unarmed, the neck as short (a character of little or no value), the posterior segments subquadrate and imbricate, the genital pores as unilateral, the length of the worm as 12^{mm} to 90^{mm}, breadth as 2^{mm}. In other words, there is neither a single distinctive character nor a collection of characters given in this diagnosis. In his second paper (1860, pp. 254–255; Taf. VII, 5–8) Molin repeats this diagnosis, gives four figures of the worm which are almost useless, except fig. 7, in which the genital pores are figured in the middle of the lateral margin, and in which some irregularly-shaped masses are drawn, which evidently represent egg capsules. He also adds three observations to the effect that he collected 42 specimens from one chicken, of which number only 2 were mature, the others being very small. He describes a mosaic structure of the segment caused by egg capsules, each of which contains from 5 to 20 ova. Although the rostellum is unarmed, the form differs in organization from the other unarmed forms. These are all of the characters ever given by Molin to the species, and it must, indeed, be admitted that they are not sufficient to determine any worm with certainty. Molin's diagnosis, without the type specimens, is therefore useless.

As far as any original observations are concerned Molin's species *T. tetragona* then rested for a number of years. In 1880 Mégnin (1880, p. 119) mentioned *T. echinobothrida* as a nomen nudum. In 1881 two parasites of chickens, very similar to if not identical with *T. tetragona*, were described as new. Mégnin described and figured *T. echinobothrida* as a new species with the characters given in the diagnosis above (p. 49). A careful study of both figures and description shows that the most important characters at present to be considered are the hooks upon the rostellum, said to be about 100 in number, 8 μ long, the rows of hooks upon the suckers (6–7 rows), those of the middle row being the largest; genital pores irregularly alternate; eggs 90 μ in diameter, spherical, arranged in groups of 6–7 in roundish egg capsules.

In March of the same year[1] (1881) Piana (1882, pp. 387-391, 1 plate) presented a paper before the *Accademia delle Scienze di Bologna*, in which he described as a new species *T. bothrioplitis*, a cestode which he found causing serious damage to poultry, producing tubercles in the intestine. The chief zoological characters taken as a basis for the species are as follows:

Head 0.35^{mm} in diameter; retractile hemispherical rostellum armed with hooks (number not given, but evidently ca. 200, form shown in drawing); suckers with seven or eight concentric rows of hooks (form as per drawing), hooks not all of same size; neck very long, containing ovoid calcareous corpuscles; genital pores unilateral, situated somewhat below (distally) the middle of the lateral margin; cirrus short, pyriform; eggs in egg sacs.

Piana states that Rivolta and Delprato (in Ornitojatria, 1880, T. I., f. 5*a*—not accessible to me) picture the head of a cestode which produced similar nodules in the intestine of a chicken. Piana found 2 cysticercoids in Helix (whether in *H. carthusianella* or *H. maculosa* is not clear to me) which agree quite closely with the head of the parasite found in chickens; no experiments were made to demonstrate that this cysticercoid is the larval form of the worm in question, but their specific identity is assumed from their similarity. Piana was acquainted with Mégnin's paper, but separated his form from Mégnin's species chiefly on account of the form of the hooks on the suckers, the number of hooks on the rostellum, and the arrangement of the genital pores. Krabbe (1882, pp. 361-364, Tab. II, figs. 55-60) published as *Tænia tetragona* Molin, some cestodes which Fedschenko had found in chickens in Turkestan. He admits the total inadequacy of Molin's figures and descriptions, but determines his specimens as *T. tetragona* on account of the egg capsules. The characters given are as follows:

Length to 250^{mm}, breadth, 1.6^{mm}; posterior segments, 1.2^{mm} long by 1.6^{mm} broad. Head provided with a short and broad retractile rostellum, surrounded by about 200 hooks arranged in a double row; hooks measured 6 μ long from the apex of the prong to the end of the dorsal root; ventral root 11 μ long; suckers surrounded by several rows of similar instable hooks of different form from those of *T. australis*. Genital pores unilateral; cirrus smooth, 21 μ long by 8 μ thick. Eggs arranged in egg sacs, 10-12 ova in a group, 40 to ca. 90 groups in a segment.

Since Krabbe's paper, authors have as a rule accepted *T. tetragona* as a good species. Blanchard (1891B, pp. 433, 436) recognized *D. echinobothrida* as a distinct species; recognized *D. tetragona* (Molin) as valid, and made *T. bothrioplitis* a synonym of *D. tetragona*. Grassi & Rovelli (1892, p. 84) claim to have recognized both *T. tetragona* Molin and *T. bothrioplitis* Piana, and state that they have found both forms; *T. echinobothrida* Mégnin they did not find, but they think it is possibly identical with *T. bothrioplitis* Piana. Railliet (1893, pp. 306-307) has followed Blanchard (1891).

From the above it is questionable whether Molin's specific name *tetragona* can be retained, unless the originals can be found and redescribed, for the description given by Molin is unrecognizable without the types. It might possibly be retained upon the ground that it is impossible to show that *T. tetragona* of present authors is not identical with *T. tetragona* Molin. I refrain temporarily from suppressing the name, as I hope the types may be reexamined. Krabbe's description of *T. tetragona* can hardly be taken into consideration in this question, as there is nothing to show that his specimens are identical with Molin's forms, and as Krabbe himself admits the uselessness of Molin's description and figures. The differences between the species described by these three authors (Mégnin, Piana, and Krabbe) are very slight and can for the most part be explained by contraction, insufficiency of material, and lack of details. The description of the hooks of the suckers of *T. echinobothrida* (as being so simple) should, I believe, be taken with reserve. The hooks are very small and are not easily studied. The fact that the genital pores are described as irregularly alternate by Mégnin and unilateral by Piana and Krabbe is not, in my opinion, a serious difference in this genus. This opinion, radical as it may appear, is based upon the following observations:

---

[1] The date of publication of the volume for 1881 is given upon the cover as 1882, but a preliminary notice of this paper appeared in the Rendiconto in 1881. This preliminary notice, however, is altogether too incomplete to hold should the question of priority be raised between Mégnin's *T. echinobothrida* and Piana's *T. bothrioplites*. Further, as Piana cites Mégnin's article in the final paper, Mégnin's name must be given precedence, should these two forms prove identical. Piana's *T. bothrioplites* of 1881 is to all intents and purposes a nomen nudum, and his species *T. bothrioplitis* should be dated 1882.

The worms which Dr. Moore found producing a nodular disease in chickens give rise to the same pathological conditions as the form described by Piana, and agree with Piana's species in regard to the armed rostellum, the form and size of the hooks, both on the rostellum and suckers, and in almost every other character mentioned by Piana. *The genital pores vary in different specimens.* In some specimens they are entirely unilateral; in other specimens all but one or two may be on the same side of the worm, in fact it is often necessary to mount the entire strobila before it is possible to find an alternating pore; in still other specimens the pores are extremely irregular. The specimens with irregularly alternate genital pores agree in all other respects, so far as I can see, with Piana's form. The only difference between these specimens and Mégnin's description appears to be (1) the number of hooks upon the rostellum (Mégnin estimates them at about 100, the American forms possess *ca.* 200–208); (2) the form of the hooks on the suckers (possibly due to misinterpretation as the form of hooks Mégnin describes is otherwise unknown in this group); and (3) the arrangement of the hooks on the suckers (in Mégnin's form the largest hooks are in the center row, in the American form the largest hooks are those of the external row). This latter point of difference should not be given too much weight, as Mégnin evidently made no microtome sections, and this point could hardly be established definitely otherwise.

In short, I incline to the belief that *tetragona, echinobothrida,* and *bothrioplitis* all represent one and the same species.

c. Genital pores unilateral.

24. **Davainea Friedbergeri** (von Linstow, 1878) R. Blanchard, 1891.

(1878, *Tænia Friedbergeri* von Linstow [May 16]; ? 1878, *Tænia agama* Mégnin [August]; ? 1878, *T. infundibuliformis* var. *phasianorum* Mégnin [September]; 1888, *T. cesticillus* var. *phasianorum* Neumann.)

[Pl. XVIII, figs. 236–242.]

Diagnosis: Strobila up to 200^{mm} and more long by 2^{mm} to 3^{mm} wide. Head pyriform, 0.386^{mm} broad by 0.30^{mm} long; rostellum armed with a double row of hooks, 75 in each row, 12 μ long; suckers elliptical, armed with 4–5 rows of hooks, of which those on the middle row are smallest. Neck thin, 2^{mm} to 3^{mm} long. Anterior segments very short, the following gradually increase in length, the distal borders projecting so as to give a serrate appearance to the worm; in the posterior sixth the segments become moniliform, the last segments almost globular, frequently orange in color. Genital pores unilateral, in middle of the margin. Ova 34 μ to 38 μ, oncospheric hooks 6.5 μ.

Development: Unknown; Friedberger and Mégnin think that ants ("*Formica rufa?*") form the intermediate host, but experiments (Friedberger) were negative.

Hosts: Pheasants (*Phasianus colchicus*).

Geographical distribution: Germany and France.

Epidemics: Friedberger (1877, pp. 99–112) gives quite an extensive account of an outbreak of disease among pheasants which he attributed to the presence of the large number of tapeworms. A remarkable difference in the development of the young pheasants was noticed.

Many of them became sick. The appetite remained good for the most part, but the animals grew dull and their feathers became ruffled. Suddenly the animals would wake up, run around, and take food; then they would quiet down again, close their eyes, and finally die.

Several post-mortems were made, and in all cases numerous tapeworms were found in the intestine. A purulent, desquamative, intestinal catarrh and general anæmic condition were constant.

In August, 1878, Mégnin (1878A, p. 825) described as a new species (*T. agama*), afterwards (September, 1878B, p. 927) proposing to make it a variety (*T. infundibuliformis* var. *phasianorum*), a tapeworm which he found creating considerable trouble in the pheasantries near Paris and Fontainebleau. He gave the following characters:

Not over 60^{mm} long; head small, with about 100 hooks; neck variable, long and filiform or short. Head not over $\frac{1}{4}^{mm}$ broad; body 1^{mm} to 3^{mm} broad. Ovary fills the entire posterior half of the body without being localized in each segment; segments detach themselves as round discs, rather thick, and 1.7^{mm} to 2^{mm} in diameter, filled with eggs, collected in egg-sacs, about 7 eggs being present in each sac and about 80–100 sacs in each segment. Mégnin suggests that ants form the intermediate host.

The parasites injured their hosts by stopping up the bowels, but good results in treatment resulted from administering powdered Kamala mixed with the food. In the second note Mégnin states that the pores are unilateral.

Neumann (1888, p. 433; 1892A, p. 471; 1892B, p. 485) erroneously attributes the combination *Tænia cesticillus* var. *phasianorum* to Mégnin (1887, p. 828); (this reference given by Neumann should undoubtedly read 1878, p. 928, as there were only 823 pages in the Recueil of 1887, and Mégnin apparently did not publish upon this species in 1887, i. e., so far as I have been able to trace). Railliet (1893, pp. 308–309) thinks it probable that Mégnin's species is identical with the worm described by Friedberger (1877) and named by von Linstow (1878).

25. **Davainea crassula** (Rudolphi, 1819) Railliet, 1893.

(1819, "*T. sphenocephala* Rud.," 1810 of Rudolphi; 1819, *T. crassula* Rud., (?1789, *Tænia serpentiformis i. T. turturis* Gmelin; ?1800, *Alyselminthus Columbæ* Zeder; ?1803, *Halysis Columbæ* (Zeder, 1800) Zeder; ?1810, *Tænia sphenocephala* Rud.; ?1891, *Davainea Columbæ* (Zeder, 1800) R. Bl.)

[Pl. XVIII, figs. 243–246.]

Diagnosis: 200^{mm} to 400^{mm} long by 4^{mm} broad. Head oval, rostellum obtuse, armed with about 60 hooks 10 μ to 11 μ long. Suckers rounded, armed with spines. Neck rather long. Anterior segments very short, the following segments a little longer and very wide, the posterior segments infundibuliform. Genital pores unilateral. Eggs united in groups of 10–12 in a capsule. Development unknown.

Hosts: Domestic pigeon (*Columba livia domestica*); European rock pigeon (*Columba livia*); turtle dove (*Turtur turtur*); rock partridge (*Caccabis saxitilis*); ? tame duck (*Anas boschas dom.*); parroquet (*Psittacus erithacus*) [perhaps *D. leptosoma*?]. Epidemics: None recorded.

Little more is known of this worm than the actual fact that the parasites described under the synonymy above are found in pigeons.

Zeder (1800, pp. 281–282) found a worm in the turtle dove which he named *Alyselminthus columbæ*, changing the name three years later to *Halysis columbæ*. This worm Rudolphi (1810, pp. 94–95) renamed *Tænia sphenocephala*, so there is evidently no doubt that these three terms are synonymous. Rudolphi includes in his literature a worm which Goeze (1782, p. 394) mentioned in a footnote as having been found in the turtle dove and which Gmelin (1790, p. 3070) quoted from Goeze as *Tænia turturis* under *T. serpentiformis*. It is entirely an assumption that Goeze's form is identical with Zeder's worm, although Gmelin's name refers to Goeze's species. Rudolphi (1819, pp. 154, 506–508) described as *T. sphenocephala*, evidently considering them identical with his *sphenocephala* of 1810, some worms obtained by Bremser; these were preserved in the Berlin Museum, were restudied by Krabbe and pronounced identical with Rudolphi's supposed new species (1819, pp. 702–704) *Tænia crassula*, types of which Krabbe also examined.

T. sphenocephala Rud., 1819 and *crassula* Rud., 1819, are evidently the earliest specific names to which we can refer with certainty, although the earlier names may be looked upon as probable but unidentifiable synonyms. According to page-priority *T. sphenocephala* should stand, but as that is an uncertain earlier synonym, and as Railliet has already used *crassula*, I retain the latter name for the present.

There are certain other species which must be considered in connection with this genus, but most of which are but little known at present. The following characters are taken from Krabbe (1869) and Blanchard (1891, pp. 434–438):

A. Avian parasites:

Davainea struthionis (Parona, 1885)—(Syn. 1810, *Tænia struthio cameli* Rudolphi, nomen nudum; 1819, *T. struthionis* Rudolphi, nomen nudum; 1885, *T. struthionis* Parona; 1893, *T.* (*Davainea*) *struthionis* von Linstow.) Parona's description of this parasite from ostriches is not accessible to me.

Davainea insignis (Steudener, 1877) R. Bl., 1891 (Syn. 1877, *Tænia insignis* Steudener). 100^{mm} to 130^{mm} long; rostellum armed with double crown of minute hooks; suckers also armed with gyriniform hooks, smaller than those of the rostellum, points directed inward; host: *Carpophaga oceanica*. (Original not at my disposal, I quote from R. Blanchard, 1891, pp. 434–435.)

Davainea australis (Krabbe, 1869) R. Bl., 1891 (Syn. 1869, *Tænia australis* Krabbe). Strobila 400^{mm} long, 1.2^{mm} broad; rostellum with a double row of 340–360 hooks 12 μ to 14 μ long; suckers with hooks, 5 μ to 11 μ long; genital pores unilateral; host: *Dromaius Novae-Hollandiæ*.

Davainea urogalli (Modeer, 1790) R. Bl., 1891. (Syn. after Krabbe 1869, p. 344: 1846, *Tænia tumens* Mehlis; 1850, *T. microps*). Strobila 300^{mm} long; rostellum with double crown of ca. 100 hooks 10–11 μ long; genital pores unilateral; hosts: *Tetrao urogallus; Tetrao tetrix; Cacabis saxatilis; Centrocercus urophasianus; Tetraogallus himalayanus.*

Davainea frontina (Dujardin, 1845) R. Bl., 1891. (Syn. after Krabbe, 1869: 1810, *Tænia crateriformis* Rudolphi, pars; 1845, *T. frontina* Dujardin.) Strobila 100^{mm} long by 1^{mm} broad; head 380 μ broad, rostellum 126 μ surrounded by a double crown of about 300 hooks 8 μ long; suckers 140 μ in diameter, armed with a large number of small hooks; genital pores unilateral; hosts: *Oriolus galbula, Picus viridis, ? P. major.*

Davainea circumcincta (Krabbe, 1869) R. Bl., 1891. (1869, *Tænia circumcincta* Krabbe). Strobila 120^{mm} long by 2^{mm} broad; rostellum armed with a double crown of about 300 hooks 11 μ to 12 μ long; suckers armed; genital pores ?; eggs in egg sacs; host: *Ardea garzetta*.

Davainea leptosoma (Diesing, 1850) R. Bl., 1891. (1850, *Tænia leptosoma* Diesing.) Strobila 160^{mm} long by 2^{mm} broad; rostellum with a double (?) crown of hooks 11 μ to 13 μ long; hooks on suckers ?; genital pores unilateral; host: *Psittacus erithacus.*)

B. Mammalian parasites.

Davainea madagascariensis (Davaine, 1870) R. Bl., 1891. (1869, *Taenia madagascariensis* (Davaine), found in man.

Davainea Salmoni Stiles, 1895, found in *Lepus sylvaticus* and *Lepus melanotis*.

Davainea retractilis Stiles, 1895, found in *Lepus arizonæ*.

Davainea contorta Zschokke, 1895, found in *Manis pentadactyla*.

Genus **ECHINOCOTYLE** R. Blanchard, 1891.

Diagnosis: Body short and thin. Head elliptical or subspherical, provided with a long rostellum capable of being completely retracted, and armed with a single row of 10 hooks; dorsal root much longer than feeble ventral root. Suckers armed with three series of hooks, whose prongs point posteriorly; one series situated in the longitudinal axis of the sucker, one series on the borders of each side. Type species, *E. Rosseteri* R. Bl., 1891.

Development: Cysticercoid (Cercocystis) in the body cavity of Ostracodes.

Hosts: Domestic ducks (*Anas boschas dom.*); Bengal ducks.

26. **Echinocotyle Rosseteri**, R. Blanchard, 1891.

(1891, "*Tænia lanceolata* Goeze" of Rosseter.)

[Pl. XIX, figs. 247–251.]

Diagnosis: Strobila (young specimens) 1.5^{mm} long with 26 segments present; breadth, 0.18^{mm}. Head subspherical, 85 μ to 155 μ long by 75 μ to 105 μ broad; rostellum long, with single crown of 10 hooks on extremity, hooks measure 31 μ to 38 μ long; suckers oblong, 67 μ to 90 μ by 27 μ to 32 μ; muscular wall much reduced, concavity nearly effaced and visible only on account of the hooks; 100–130 hooks on each sucker with base 7 μ to 8 μ, prong 3 μ to 4 μ. Neck 90 μ to 140 μ by 45 μ to 70 μ. One specimen with 20 segments, last segment 153 μ long by 195 μ broad. Genital pores near anterior corner of segment; cirrus pouch large, extending over halfway across the segment.

Type specimens: Collection Rosseter; Collection Stiles.

Life history: Cysticercoid in *Cypris cinerea* Brady.

Hosts: Adults in tame duck (*Anas boschas dom.*), experimentally by Rosseter; Bengal duck (*Anas* sp?) by Rosseter.

Geographical distribution: Canterbury (Kent), England, by Rosseter.

Rosseter (1891A., p. 438) presented a communication to the Royal Microscopical Society stating that he had infected ducks with a cysticercus and thus raised *Tænia lanceolata*. There were from 180-200 minute hooks on the head. A fuller account is given in his second paper, in which Rosseter (1891B., pp. 224–228) states that he examined the *Cypridæ* of a pond near Canterbury for cysticercoids, and noticed that *Cypris cinerea* Brady contained two species of parasites. One was the larval form of *Tænia coronula* (= *Dicranotænia coronula*); a less common form occurred in about 2 per cent of those examined.

The latter form is oval, invaginated anteriorly and provided with a long caudal appendage; cyst is not fenestrated. While developing, its substance submits to active contractions, but when fully developed to a point where it can be transmitted to vertebrates it remains quiescent; rostellum invaginated, bearing a crown of 10 hooks 32 μ long, of which three-fifths are occupied by the dorsal root; ventral root rather truncate; prong short and slightly curved. Suckers oval, armed with about 132 hooklets, arranged symmetrically around the suckers; the hooks are very delicate, about 5 μ long.

A large number of crustaceans were fed to a duck daily from February 19 to March 21. Upon killing the duck a considerable number of tapeworms, which showed the same characters as the cysticercoid, were found in the upper portion of the small intestine. The largest was 1.27^{mm} long; the greater number of specimens possessed 17 segments. Male organs were well developed, but the female organs were not visible. Rosseter believed that the adult parasite which he has thus developed was *Tænia lanceolata* Goeze.

Blanchard (1881B, pp. 420–428, figs. 1–2) examined some of Rosseter's material and recognized that this form was not identical with *T. lanceolata.* He compared it with all the other species recorded for ducks, and with other avian tapeworms possessing 10 hooks on the head and unilateral genital pores, and concluded that Rosseter's cestode represented the type (*E. Rosseteri* R. Bl.) of a new genus (*Echinocotyle* R. Bl.). He added that Rosseter had recently informed him that he had sometime previous to the discovery of the cysticercoid placed some ducks imported from Calcutta on the pond in which he had discovered the parasites; upon making an autopsy on one of these ducks Rosseter found it infested with *Echinocotyle.* Blanchard concluded from this that the Bengal ducks imported the parasites with them and infected the pond in question. Blanchard discusses the adult worm, and from this description the specific diagnosis given above is written. Rosseter (1892, pp. 361–366, Pls. XXII–XXIII) again discusses this species and figures it.

Regarding the supposed introduction of this parasite into England by ducks from Calcutta, the idea advanced by Blanchard seems very plausible. At the same time, however, Blanchard states (p. 424) that neither he nor Rosseter have been able to examine any adult specimens. Now, had the Bengal ducks brought the parasites with them, would not the duck examined by Rosseter have been infested, in all probability, with the adult form, although they unquestionably could also have become infected with a new generation from the crustaceans? I hardly see why the fact that two Bengal ducks were placed upon this pond a short time before Rosseter discovered the parasites in the crustaceans bears anything more than a possible (but not necessary or probable) connection with the presence of this species in England; the parasite has not yet been recorded from Bengal.

Genus **OPHRYOCOTYLE** Friis, 1869.

[Pl. XIX, figs. 252–255.]

Diagnosis: Head enlarged anteriorly, without rostellum, but with several infundibula whose borders are armed with a very large number of small hooks; suckers armed with several transverse rows of hooks; genital pores irregularly alternate. Type species: *O. proteus* Friis, 1869. Development unknown.
Hosts: Birds.

No members of this genus are known from domesticated birds or from very closely allied wild birds, but two species, *O. proteus* Friis, 1869 (Syn. 1875, *O. Lacazii* Villot), and *O. insignis* Lönnberg, are described from wild birds.

Infundibulum divided into 5 parts; strobila 10^{mm} to 25^{mm} long, with about 19 segments; hooks on suckers arranged in three rows; found in *Tringa alpina, Charadrius hiaticula, Calidris arenaria, Larus canus, Limosa rufa* .... *O. proteus.*
Infundibulum not divided, but its border undulated; strobila 50^{mm} to 100^{mm} and more long; found in *Hæmatopus ostrealegus* .... *O. insignis.*

GENUS INCERT. TÆNIA S. L.

A number of other tapeworms have been described from domesticated fowls, but their generic position can not be determined with the data at hand.

27. Tænia cantaniana Polonio, 1860.

[Pl. XX, fig. 256.]

Polonio (1860, pp. 21–22) describes a supposed new species of tapeworm as follows:

1. *T. Cantaniana* Polonio. Caput globosum, centro umbonatum; acetabulis cruciatim oppositis ob majorem capitis circulum; collum nullum; corpus retrorsum dilatatum, articulis supremis campanæformibus, sequentibus campanæformibus imbricatis trapezoidalis; aperturæ genitales marginales. Long, 0.013.

Habitaculum: *Meleagris Gallopavo*, in intestina, Octobri, Patavi (Polonio).

In his second paper (1860, p. 221) this form is cited and is figured on Taf. VII, 2 (vide Pl. XIX, fig. 256 of this paper). The pores are evidently unilateral. Von Linstow (1878, p. 122) includes this among the parasites of the pheasant *Phasianus colchicus*, but does not give his authority.

All subsequent remarks upon this species are based upon Polonio's statements. Blanchard (1891B pp. 439–440) thinks this form may possibly belong to the genus *Davainea*, and takes the following characters from Polonio's figure:

Suckers large and round; the head seems to be surmounted by a very short rostellum, probably retractile. The neck is quite long, distinctly separated from the head. Segments number about 60. Genital pores unilateral; cirrus pouch visible in twenty-sixth to forty-fifth segments; forty-sixth to sixtieth segments are gravid. The eggs, so far as can be judged from the figure, are scattered and isolated as in *D. proglottina*.

I can not see that Polonio's description and figure are sufficient to compel or even to allow the recognition of this specific name. If the types can be obtained and restudied, it would of course be proper to redescribe them under the specific name *cantaniana*, but until those types can be found it is useless to waste time speculating as to the possible generic or specific relations of the parasite. I propose to ignore the species entirely, on the ground that the specific name has not been accompanied by a recognizable description or figure.

28. Tænia Delafondi Railliet, 1892.

(1891, "*Tænia sphenocephala* Rud.," 1810, of Mégnin.)

[Pl. XX, figs. 257–262.]

Diagnosis: Strobila 7^{cm} to 13^{cm} long, 3^{mm} to 4^{mm} broad. Head hemispherical, rostellum and hooks absent. Suckers large. Neck 0.5^{mm} or more long, at first as broad as head, enlarging distally. Proximal segments very short, following segments slightly longer and very broad, lateral margins convex. Genital pores irregularly alternate, situated near the anterior quarter of the lateral border; two lateral ramefied uteri visible as two longitudinal rows of opaque spots; another submedian series formed by receptaculum seminis; testicles rather numerous. Ova globular $62\,\mu$ to $65\,\mu$; hooks of oncosphere $11\,\mu$ long. Development: Unknown.

Type specimens: In Alfort collection.

Hosts: Domestic pigeons (*Columba livia domestica*) by Delfond, Railliet, Mégnin, and von Linstow. Geographical distribution: France and Germany.

This appears to be a very peculiar form. Its systematic position, as well as its synonymy and anatomy, seem to me extremely uncertain.

29. **Tænia exilis** Dujardin, 1845.

Dujardin proposed this name for a tapeworm found in chickens, but the description is so insufficient that the species should be ignored entirely. The original description reads:

"Je proposerai de nommer Tænia exilis un autre tænia de la poule, bien différent aussi des précédents, mais dont je n'ai pas encore eu la tête; il est long de 20^{mm} à (?), large de 0.15^{mm} en avant, et de 0.95^{mm} en arrière, formé d'articles courts, transverses; les orifices génitaux sont unilatéraux; les pénis sont lisses, assez longs, larges de 0.015^{mm} précédés par une ample vésicule séminale, remplie des spermatozoïdes en écheveau; les œufs, presque globuleux, ont trois envoloppes; l'externe longue de 0.056^{mm} à 0.065^{mm}; la moyenne de 0.054^{mm}; l'interne de 0.032^{mm}; l'embryon, long de 0.025^{mm}, a des crochets long de 0.0125^{mm}."

Airloing (1875, pp. 427–431) claims to have found the same worm, although it is not at all evident why he should think his form identical with Dujardin's species. He gives the following characters:

Head is 0.48^{mm} long by 0.60^{mm} broad, suckers orbicular 0.20^{mm} diameter; rostellum short 43 μ in diameter, with a simple crown of 60 hooks 8 μ long; neck 5^{mm} long by 0.15^{mm} broad; segments much broader than long; anterior segments 0.33^{mm} to 0.37^{mm} by 49 μ to 50 μ, then 1^{mm} by 0.12^{mm}; middle segments 1.5^{mm} (anterior border) to 1.8^{mm} (posterior border) by 0.6^{mm}. Genital pores unilateral in anterior third of segment. Penis 36 μ by 6 μ. Eggs globular, outer membrane 58 μ to 64 μ, inner membrane 30 μ to 32 μ; hooks of oncosphere 16 μ.

30. **Tænia imbutiformis** Polonio, 1860.

(1893, *Mesocestoides imbutiformis* (Polonio, 1860) Railliet.)

[Pl. XX, fig. 263.]

Diagnosis: 8^{mm} long, head small, suckers circular. Neck absent. Posterior portion of strobila thick, anterior segments linear; following segments bell or funnel shaped; posterior segments bell-shaped. Genital pores situated on one of the surfaces of the segments. Development: Unknown.

Hosts: Wild geese (*Anser anser*) by Polonio, 1860; von Linstow (1878, p. 155) records it in domesticated ducks (*Anas boschas dom.*), but I can not trace his authority.

Geographical distribution: Padua (by Polonio). Polonio is apparently the only author who has seen this worm.

Polonio (1860A, p. 22) gives the following as original diagnosis:

3. *T. imbutiformis* Polonio. Corpus retrorsum incrassatum; caput minimum; acetabulis orbicularibus anticis; collum nullum; articuli supremi lineares, posteriores campanulato-imbutiformes, ultimi campanulati, aperturæ genitales laterales ellipticæ. Long, 0.01.

Habitaculum: *Anser ferus*, in intestinis, Octob. et Nov. Patavii (Polonio).

Polonio (1860B, p. 121) simply mentions the parasite in his list, and gives a very unsatisfactory figure of the worm. In this figure a prominent body near the lateral margin is looked upon as the genital pore. This body has much more the appearance of a testicle, cirrus pouch, or of a receptaculum seminis than it has of a genital pore. I am therefore inclined to doubt very much whether this species is correctly placed by Railliet (1893, pp. 313–314) in the genus *Mesocestoides*. Furthermore, the form is altogether too insufficiently described to be recognizable. The figure shows extreme contraction near the head.

31. Tænia megalops Nitzsch, 1829.

(1825, *Tænia anatis marilæ* Creplin.)

[Pl. XX, figs. 264–267.]

Diagnosis: Strobila up to 52^{mm} long by 0.5^{mm} broad proximally, and 0.75^{mm} broad distally. Head very large, rather tetragonal, 1.4^{mm} broad; suckers 0.57^{mm} to 0.64^{mm} in diameter; rostellum absent (?) or not prominent and (?) without hooks. Anterior segments very short, 12 times as broad as long; posterior segments twice as broad as long, "narrowed at the base, spread in form of a bell," colored yellowish by small longitudinal lines. Genital pores unilateral. Penis smooth, tubular, 70 μ by 23 μ "situated on a very prominent and swollen tubercle." Ova globular with 2 membranes; outer membrane 47 μ, inner 38 μ in diameter; oncosphere 32 μ; hooks 15 μ; the eggs are scattered through the median portion of the segments. Development: Unknown.

Hosts: Tame duck (*Anas boschas dom.*); Brazilian teal (*A. braziliensis*); European teal (*A. crecca*); pintail (*Dafila acuta*); white-headed duck (*Erismatura leucocephala*); tufted duck (*Aythya fuligula*); European scaup duck (*A. marila*); African teal (*A. nyroca*).

The chief character for this worm is the large head, but it seems extremely doubtful whether this should be taken as the basis of a species. The parasite certainly can not be recognized with certainty from the present description, and should be considered as a doubtful species until some of the original specimens can be restudied.

32. Tænia nigropunctata Crety, 1890.

[Pl. XX, figs. 268–270.]

Diagnosis: Strobila to 140^{mm} in length. Head small, 0.382^{mm} broad; (?) rostellum and hooks absent; suckers 0.166^{mm} by 0.137^{mm}. Neck short, about same breadth as head. Young segments rectangular, 0.5^{mm} long by 1^{mm} broad; older segments almost quadrangular, 2^{mm} long by 1.5^{mm} broad; mature segments 2.5^{mm} to 3^{mm} long by 1^{mm} broad. Genital pores irregularly alternate, slightly posterior to the middle of the margin. *Male genitalia:* in posterior portion of segment, testicles 12 in number, diameter 58 μ, equally distributed at sides of the uterus; vas deferens convoluted in its lateral portion and inflated to vesicula seminalis 0.176^{mm} by 0.098^{mm} within the cirrus pouch; cirrus pouch pyriform, 0.313^{mm} by 0.137^{mm}. *Female genitalia:* Ovary vitellogene gland, shell gland? At anterior border of the segment a spot is observed in the median line; from this a median stem runs distally and is divided near the height of the pore into two portions; the posterior portion, at least, represents the uterus. Ova 62 μ, with 3 shells; oncosphere 46 μ by 40 μ; hooks 15 μ.

Host: Migratory quail (*Coturnix coturnix*).

33. Tænia sp. Conard, MS.

[Pl. XXI, figs. 275–276.]

Mr. Henry S. Conard (Haverford College) has recently studied some tapeworms from chickens, evidently finding more than one species. He has kindly placed the following abstract of his work upon one of these forms at my disposal, prior to the publication of his article.

Head round-conical, somewhat four-angled, broader than long (0.098^{mm} to 0.136^{mm} long; 0.11^{mm} to 0.192^{mm} broad). Acetabula round to elliptical, 0.06^{mm} in diameter, directed slightly forward. Neck distinct, terete, 0.5^{cm} long. Proglottides trapezoidal, broader than long. Genital apertures marginal, always on the right-hand side of the segment, slightly in front of the middle. The male organs comprise a

testis; vesicula seminalis, cirrus sac and cirrus, vesicula and cirrus being the most prominent organs of the whole segment. Cirrus very short, roughened with minute prickles about perpendicular to its surface. Female organs consist of a narrow vagina, large receptaculum seminis, and a common ovary and uterus (See von Linstow, 1893). Vagina and cirrus sac are in the same transverse plane and pass dorsad to both longitudinal canals. Length 35^{mm}; breadth 0.046^{mm} to 0.47^{mm}; thickness 0.046^{mm} to 0.113^{mm}. Number of segments about 600, becoming as much as 0.39^{mm} long. Egg about 0.026^{mm} in diameter; embryos ellipsoidal, 0.016^{mm} by 0.0225^{mm}; hooks about 0.008^{mm} long.

Hab: In small intestine of common fowl, shortly back of gizzard.

Mr. Conard looks upon this form as a species of *Davainea* "with unilateral pores," although he has not as yet found any hooks upon the head. Final decision regarding the form must be reserved until the appearance of Mr. Conard's paper.

FIMBRIARIA Frölich, 1802.

(1892, *Epision* Linton.)

[Pl. XXI, fig. 271.]

This genus was proposed first by Frölich, and later by Linton, for tapeworms with an anterior hammer-like extremity. The scolex is generally (? always) wanting. Three species *F. malleus* (Goeze, 1782) Frölich, *F. mitrata,* and *E. plicatus* have been described, but most authors include them all under the general term *Tænia malleus*, which some writers look upon as a pathological condition rather than a distinct species or genus.

34. *F. malleus* has been recorded from a large number of wild birds as well as from domesticated fowls, but so far as known it does not play any important pathogenic rôle. (See Dujardin, 1845, p. 587, for the earlier literature.)

IDIOGENES Krabbe, 1868.

[Pl. XXI, figs. 272–274.]

The genus *Idiogenes* with the type and only species *I. otidis* was proposed by Krabbe for a tapeworm in which the scolex is wanting; the anterior segments become caliciform and function as a pseudo-scolex. (For an anatomical description see Zschokke, 1889, pp. 114–127, Pl. III, figs. 39–47.)

This avian tapeworm had not yet been recorded from poultry.

ADDENDUM.

During the final proof reading of this paper, I have received a recent article by Railliet (1896), in which several new propositions are made concerning certain parasites mentioned in this report.

Dipylidiinæ: The name of the subfamily, *Cystoidotæniæ*, is changed to *Dipylidinæ.* This change is in accordance with the International Code and should be adopted, the word, however, being written *Dipylidiinæ.*

Choanotænia: Railliet proposes a new genus, with *Tænia infundibuliformis* Goeze as type, in the following words:

> Le *Tænia infundibuliformis* Goeze, que j'avais placé provisoirement dans le genre *Drepanidotænia,* s'en distingue par le grand nombre des testicules, et d'une manière

> générale par la constitution de l'appareil reproducteur (Crety). Il mérite donc de devenir le type d'un nouveau genre *Choanotænia* (de *χόανον* entonnoir). *Ch. infundibuliformis,* intestin de la poule. (P. 159.)

Although I recognized the great difference in organization between *T. infundibuliformis* (as described by Crety) and the other species of *Tænia* which have been placed in *Drepanidotænia,* and am inclined to consider it generically distinct from these worms (see p. 45), and although I have the highest regard for the opinion of my colleague and for his keen foresight, particularly in systematic questions, I prefer to reserve judgment upon his new genus until its type species and a few allied forms are more thoroughly understood, especially as it appears to me that *T. infundibuliformis,* as determined by various authors, is rather a heterogenous and collective species.

Dicranotænia sphenoides: Railliet correctly suppresses the specific name *cuneata* Linstow nec Batsch (see p. 35).

EXPLANATION OF CHART.

In the following chart I have given the records of the tapeworms found in the domesticated poultry and in the allied wild birds. The sign □ signifies that the parasite is recorded only for domesticated birds, × for wild birds, ⊞ both domesticated and wild birds.

The names of the hosts are given at the left, those of the parasites at the top. The first row of numbers refers to the numbers in the A. O. U. check list of North American birds, the second column of numbers to the corresponding numbers in von Linstow's Compendium of Helminthology (1878, 1889).

For the revision of the host names I am indebted to Drs. Fisher and Palmer, of the Division of Ornithology. As many of the host names used by helminthologists are not used by modern ornithologists, these gentlemen have traced out the proper names of the birds in question from the host names given in helminthological articles.

In noting the species of parasites under the various hosts, it has been extremely difficult to determine what records should be accepted and what ones should be rejected. As nearly all of the older records are based upon determinations by external form instead of internal anatomy, I believe the time has come when we should begin an entirely new series of records of hosts.[1]

All records of tapeworms, except in the case of type specimens where the determination has been made solely upon external form, should, I believe, be taken only as approximate and provisional.

---

[1] This can easily be accomplished if helminthologists will designate all new records in some way. In the Revision of the Adult Cestodes of Cattle, Sheep, and Allied Animals, and also in my recent article on *Fasciola magna,* I have commenced such a new series of host determinations for the parasites of the domesticated animals by starring (*) the parasites under each host in those cases where I have examined the species of parasites from the host in question (or from material said to have come from that host, as *T. denticulata,* for instance. This latter record is, in my opinion, erroneous.)

DESCRIPTION OF PLATES.

PLATE I, FIGS. 1-11.—*Cotugnia digonopora.*

Fig. 1. Head and neck. x8.
Fig. 2. Head and neck in press preparation. Zeiss 2, A.
Fig. 3. View of armed rostellum, *en face*, press preparation; *cgl.*, ? glandular cells of rostellum. Zeiss 3, C.
Fig. 4. View of hooks on rostellum. Zeiss 2, $\frac{1}{12}$.
Fig. 5. Side view of isolated hook. Zeiss 3, $\frac{1}{12}$.
Fig. 6. Four young segments with genital anlagen. x8.
Fig. 7. Three young segments: *d.*, vas deferens; *ov.*, ovary. Zeiss, 1, a^3.
Fig. 8. Segments from middle of strobila, with organs more completely developed: *d.*, vas deferens; *t.*, testicles; *tp.*, cirrus pouch; *ov.*, ovary. Zeiss 1, a^3.
Fig. 9. Still older segments in which the "ovaric capsules" (=egg sacs) are developing: *ag.*, genital pore; *co.*, "ovaric capsules"=egg sacs; *d.*, vas deferens; *ov.*, ovary; *p.*, cirrus; *tp.*, cirrus pouch; *v.*, vagina. Zeiss 1, a^3.
Fig. 10. End segments with oncosphere: *ag.*, genital pore; *co.*, eggs.
Fig. 11. Longitudinal section of mature segment: *co.*, "ovaric capsules"=egg sacs; *em.*, oncosphere; *ie*, eggshell; *g.*, eggshell; *pr.*, parenchyma. Zeiss 2, $\frac{1}{12}$.

All figures from Pasquale, 1890, figs. 1-11.

PLATE II, FIGS. 12-20.—*Cotugnia bifaria* and *Amabilia lamelligera.*

[Figs. 12-17. *Cotugnia bifaria,* after Monticelli, 1891, Taf. VIII, figs. 8-13.]

Fig. 12. Head and anterior segments, greatly enlarged. Monticelli, fig. 8.
Fig. 13. Young segments, enlarged on same scale. Monticelli, fig. 9.
Fig. 14. Middle segments, enlarged on same scale. Monticelli, fig. 10.
Fig. 15. End segments, enlarged on same scale. Monticelli, fig. 11.
Fig. 16. Segment mounted in glycerin and acetic acid, showing genital organs: *ag.*, genital pore; *df.*, vas deferens; *ov.*, ovary; *rse.*, vesicula seminalis; *t.*, testicles; *v.*, vagina. Greatly enlarged. Monticelli, fig. 12.
Fig. 17. Armed cirrus, greatly enlarged. Monticelli, fig. 13.

[Figs. 18-20. *Amabilia lamelligera.* Owen's (1835) original figures.]

Fig. 18. Adult strobila, natural size. Owen's fig. 21.
Fig. 19. "Four segments of the same magnified." Owen's fig. 22.
Fig. 20. "Longitudinal section of 3 posterior segments, showing the ova collected near the base of the lemniscus." Owen's fig. 23.

PLATE III, FIGS. 21-36.—*Dicranotænia coronula, Dicranotænia æquabilis, Dicranotænia furcigera,* and *Tænia conica.*

[Figs. 21-28. *Dicranotænia coronula:* 21-24 after Krabbe, 1869; 25-28 after Mrázek, 1890.]

Fig. 21. Anterior portion of scolex with hooks. x240. After Krabbe, 1869, Tab. VIII, fig. 216. Host: Domesticated duck.
Fig. 22. Isolated hook. x920. After Krabbe, 1869, Tab. VIII, fig. 217.

Fig. 23. Isolated ovum with oncosphere. x240. After Krabbe, Tab. VIII, 1869, fig. 218.

Fig. 24. Isolated hook. x920. After Krabbe, 1869, Tab. VIII, fig. 219. From Coll. Siebold. Host: European golden eye (*Glaucionetta clangula*).

[Figs. 25–28. Cysticercoids from *Cypris ovum* and *C. compressa*.]

Fig. 25. Fully developed larva, showing the scolex invaginated in the cyst; and the long tail with the 6 oncospheric hooks; *ex.*, excretory system; *h.*, cuticle; *cu.*? "pores of the cuticle" or ? muscles; *hp.*, hypodermis; *p.*, parenchyma of neck, with calcareous corpuscles. After Mrázek, 1890, Tab. V, fig. 11.

Fig. 26. Another view of a cysticercoid. After Mrázek, 1890, Tab. V, fig. 12.

Fig. 27*a–c*. Isolated hooks. After Mrázek, 1890, Tab. V, fig. 13*a–c*.

Fig. 28*a–c*. Oncospheric hooks. After Mrázek, 1890, Tab. V, fig. 14*a–c*.

[Figs. 29–30. *Dicranotænia æquabilis*.]

Fig. 29. Five hooks from the rostellum. x240. After Krabbe, 1869, Tab. VIII, fig. 212, from Rudolphi's original material in the Berlin Museum.

Fig. 30. Isolated hook from the rostellum. x920. After Krabbe, 1869, Tab. VIII, fig. 213, from specimen in Creplin's collection.

[Figs. 31–34. *Dicranotænia furcigera*.]

Fig. 31. Isolated hook from the rostellum. x210. After Dujardin, 1845, Pl. IX. Fig. A. Host: Wild duck.

Fig. 32. Isolated hook from the rostellum. x920. After Krabbe, 1869, Tab. VIII, fig. 206, from Nitzsch's original material. (See Rudolphi, 1819, p. 528.) Host: Mallard.

Fig. 33. Ovum with oncosphere. x240. After Krabbe, 1869, Tab. VIII, fig. 207, from Nitzsch's original material.

Fig. 34. Ten hooks on rostellum. x240. After Krabbe, 1869, Tab. VIII, fig. 205, from material collected in Iceland in 1863. Host: Mallard.

[Fig. 35–36. *Tænia conica* = ? *Dicranotænia furcigera*.]

Fig. 35. Natural size: *a*, head; *b*, rostellum; *c*, body. After Molin, Tab. VII, fig. 1.

Fig. 36. Enlarged. After Molin, 1861, Tab. VII, fig. 2.

PLATE IV, FIGS. 37–53.—*Dicranotænia sphenoides* and *Drepanidotænia lanceolata*.

Figs. 37–42. *Dicranotænia sphenoides*.

Fig. 37. Strobila, natural size. After von Linstow, 1872, Taf. III, fig. 9*a*, of *Tænia cuneata*.

Fig. 38. Scolex and anterior segments, enlarged. After von Linstow, 1872, Taf. III, fig. 9, of *T. cuneata*.

Fig. 39. Isolated hook from the rostellum. After von Linstow, 1872, Taf. III, fig. 10, *T. cuneata*.

Fig. 40. Cysticercoid from an earthworm. Koritska, *oc.* 3, *obj.* 4. After Grassi & Rovelli, 1892, Tav. IV, fig. 12.

Fig. 41. Tranverse section of the same: *cav.*, "cavity of the gastrula;" *cis.*, cyst; *par. est.*, external wall; *par. int.*, internal wall; *ros.*, rostellum; *ven.*, sucker. Koritska, *oc.* 3, *obj.* 7. After Grassi Rovelli, 1892, Tav. IV, fig. 11.

Fig. 42. Three hooks (*b*, *c*, and *d*) from rostellum of *T. cuneata;* Koritska, *oc.* 3, *obj.* 8; a fourth hook (*a*) greatly enlarged. After Grassi & Rovelli, 1892, Tav. IV, fig. 13.

[Figs. 43–53. *Drepanidotænia lanceolata.*]

Fig. 43. Original type figure. After Bloch, 1782, Tab. I, fig 5.
Fig. 44. Anterior portion, enlarged. After Bloch, 1782, Tab. I, fig. 6.
Fig. 45. Worm from a goose. Natural size. After Goeze, 1782, Tab. XXIX, fig. 3.
Fig. 46. The eight hooks upon the rostellum. x240. After Krabbe, 1869, Tab. VI. fig. 143.
Fig. 47. Two isolated hooks. x920. After Krabbe, 1869, Tab. VI, fig. 144.
Fig. 48. Extruded cirrus. After Feuereisen, 1868, Taf. X, fig. 8.
Fig. 49. Cirrus pouch with cirrus. After Feuereisen, 1868, Taf. X, fig. 9.
Fig. 50. Isolated segment: *a*, cirrus pouch; *c*, testicle; *i*, vitellogene gland; *k*, ovary; *m*, receptaculum seminis and vagina. After Feuereisen, 1868, Taf. X, fig. 17. Some misinterpretations have undoubtedly been made in this figure. The genital system must be restudied.
Fig. 51. Head and anterior segments. x100. After Railliet, 1886, fig. 163A; also Railliet, 1893, fig. 195A.
Fig. 52. Ovum with oncosphere. x300. After Railliet, 1886, fig. 163B; also Railliet 1893, fig. 195 B.
Fig. 53. Head and anterior segments. x100. After Mégnin, 1881, Pl. IV, fig. 3.

PLATE V, FIGS. 54–66.—*Drepanidotænia lanceolata* and *Drepanidotænia fasciata.*

[Figs. 54–55. *Drepanidotænia lanceolata.*]

Fig. 54. Transverse section of segment. x20. After Mégnin, 1881, Pl. IV, fig. 6.
Fig. 55. Isolated cirrus. x50. After Mégnin, 1881, Pl. IV, fig. 7.

[Figs. 56–66. *Drepanidotænia fasciata.*]

Fig. 56. Rostellum with 5 of the 8 hooks. x240. After Krabbe, 1869, Tab. VII, fig. 156.
Fig. 57. Isolated hook. x920. After Krabbe, 1869, Tab. VII, fig. 157.
Fig. 58. Head with extended rostellum possessing 8 hooks. After Feuereisen, 1868, Taf. X, fig. 1. (*"T. setigera" =Drep. fasciata.*)
Fig. 59. Isolated hook. After Feuereisen, 1868, Taf. X, fig. 2. (*"T. setigera" =Drep. fasciata.*)
Fig. 60. Cirrus pouch. After Feuereisen, 1868, Taf. X, fig. 4. (*"T. setigera" =Drep. fasciata.*)
Figs. 61–62. Cirrus from above and from the side. After Feuereisen, 1868, Figs. 5, 6. (*"T. setigera" =Drep. fasciata.*)
Figs. 63–66. Isolated segments: *a*, cirrus pouch; *b*, genital pore; *c*, testicles; *d*, cirrus; *e*, vas deferens and vesicula seminalis; *g*, vagina; *h*, genital cloaca; *i*, vitellogene glands; *k*, ovary; *m*, receptaculum seminis; *n*, uterus (?). After Feuereisen, 1868, Taf. X, figs. 10–13. Feuereisen has probably misinterpreted some of these organs and they should be restudied.

PLATE VI, FIGS. 67–76.—*Drepanidotænia fasciata.*

Fig. 67. Body of *Cyclops agilis*, containing a larval tapeworm. After Mrázek, 1890, Tab. V, fig. 1.
Fig. 68. Larval tapeworm, with enormously long tail, isolated from the crustacean. After Mrázek, 1890, Tab. V, fig. 2.
Fig. 69. (? Side view.) After Mrázek, 1890, Tab. V, fig. 3.
Fig. 70. Cysticercoid, with anterior portion of the tail. After Mrázek, 1890, Tab. V, fig. 5.
Figs. 71–72. Hooks from rostellum, greatly magnified. After Mrázek, 1890, Tab. V, figs. 7–8.

Figs. 73–75. Hooks as seen in position on the rostellum. After Mrázek, 1890, Tab. V, figs, 6 and 9*a*–*b*.

Fig. 76. After Mrázek, 1890, Tab. V, fig. 10.

PLATE VII, FIGS. 77–91.—*Drepanidotænia fasciata* and *Drepanidotænia gracilis*.

[Figs. 77–79. *Drepanidotænia fasciata*.]

Fig. 77. Cysticercoid with anterior portion of tail. After Mrázek, 1890, Tab. V, fig. 4.

Fig. 78. Cysticercoid with extended head; the oncospheric hooks are still visible in the tail. After Mrázek, 1891, Tab. V, fig. 1.

Fig. 79. Isolated hook from rostellum. After Mrázek, 1891, Tab. V, fig. 2.

[Figs. 80–91. *Drepanidotænia gracilis*.]

Fig. 80. "*Tænia collo longissimo*." After Bloch, 1872, Taf. III, fig. 3. Is perhaps identical with *Drep. gracilis*.

Fig. 81. Head of same, enlarged. After Bloch, 1782, Taf. III, fig. 4.

Fig. 82. Anterior portion of head, showing the arrangement of the 8 hooks upon the rostellum. x240. After Krabbe, 1869, Tab. VII, fig. 154.

Fig. 83. Isolated hook. x920. After Krabbe, 1869, fig. 155.

Fig. 84. Strobila, natural size. After von Linstow, 1872A, Taf. XXI, fig. 3. Host: Goosander.

Fig. 85. Head. x90. After von Linstow, 1872A, Taf. XXI, fig. 5.

Fig. 86. Isolated hook. x500. After von Linstow, 1872A, Taf. XXI, fig. 2.

Fig. 87. End of proglottid with extruded cirrus. x150. After von Linstow, 1872A, Taf. XXI, fig. 4.

Fig. 88. Head of *Tænia gracilis tadornæ* from the common sheldrake (*Tadorna tadorna*). After Lönnberg, 1889, Pl. I, fig. 1.

Fig. 89. Free cysticercoid in the perch (*Perca fluviatilis*). x350. After von Linstow, 1872A, Pl. XXI, fig. 1.

Fig. 90. Excretory system of the head and neck. After Mrázek, 1891, Tab. V, fig. 16. Zeiss 3, D.

Fig. 91. End cell of excretory system. After Mrázek, 1891, Tab. V, fig. 17. Zeiss 3, F.

PLATE VIII, FIGS. 92–99.—*Drepanidotænia gracilis*.

Fig. 92. A cysticercoid in process of development. A differentiation is noticed into the body and the tail, and a small knob is noticed on the anterior extremity. The 6 oncospheric hooks are present in the tail. After Mrázek, 1891, Tab. VI, fig. 25.

Fig. 93. Another stage of the cysticercoid. An invagination is noticed on the anterior extremity; the middle portion of the body is occupied by a cavity filled with a spongy tissue. After Mrázek, 1891, Tab. VI, fig. 26.

Fig. 94. Cysticercoid with the anterior portion of the tail: *h.*, peripheral hyaline layer; *e.*, excretory canals; *pr.*, vibratory cells (see Pl. VII, fig. 86), "Pronephridiostomes." Zeiss 3, D. After Mrázek, 1891, Tab. V, fig. 13.

Fig. 95. Normal form of hook. Zeiss 3, F. After Mrázek, 1891, Tab. V, fig. 14.

Figs. 96–98. Three hooks, with variously arranged chitin. Zeiss 3, D. After Mrázek, 1891, Tab. V, fig. 15*a*–*c*.

Fig. 99. A cysticercoid with extended head: *r.*, rostellum; *c.*, cyst; *pr.*, tail with oncospheric hooks. Zeiss 1, D. After Mrázek, 1891, Tab. VI, fig. 18.

PLATE IX, FIGS. 100–111.—*Drepanidotænia anatina*.

Fig. 100. Rostellum with 5 of the 10 hooks. x240. After Krabbe, 1869, Tab. VI, fig. 114.

Fig. 101. Isolated hook. x920. After Krabbe, 1869, Tab. VI, fig. 115.

Fig. 102. Ovum. x240. After Krabbe, 1869, Tab. VI, fig. 116.

Fig. 103. Transverse section of a portion of one segment, to show the anatomy: *h.*, testicles; *vd.*, vas deferens; *bk.*, fertilization canal; *ut.*, uterus; *lm.*, longitudinal muscles; *s. bl.*, vesicula seminalis; *gz.*, ganglion cells; *p. s.*, præputial sac; *c.*, cirrus; *cb.*, cirrus pouch; *l. k.*, longitudinal canals; (small dorsal canal; large ventral canal); *r. sem.*, receptaculum seminis; *ov.*, ovary; *eig.*, oviduct; *d. st.*, vitellogene gland; *d. g.*, vitello-duct; *sch. dr.*, shell gland; *af.*, canal of same. After Schmidt, 1894, Taf. VI, Fig. C.

Fig. 104. Ovum with oncosphere. After Schmidt, 1894, Taf. VI, fig. 1.

Fig. 105. The oncosphere has developed into a round mass in which a cavity appears. After Schmidt, 1894, Taf. VI, fig. 2.

Fig. 106. Stage in which the round mass has become elongate; *ebl.*, terminal vesicle. After Schmidt, 1894, Taf. VI, fig. 3.

Fig. 107. Stage with anlage of the rostellum and suckers; the body has become constricted into the scolex, cyst, and tail; the excretory system is partly developed. After Schmidt, 1894, Taf. VI, fig. 4.

Fig. 108. Transverse section in the second period of development. After Schmidt, 1894, Taf. VI, Fig. *a*.

Fig. 109. Longitudinal section of a later stage of the second period of development. After Schmidt, 1894, Taf. VI, Fig. *b*.

Fig. 110. Extended cysticercoid; *s.*, anterior point of rostellum; *r.*, rostellum; *ex.*, excretory organ; *h. r.*, posterior rostellum sac; *ebl.*, terminal vesicle. After Schmidt, 1894, Taf. VI, Fig. B.

Fig. 111. Two isolated hooks from the rostellum. After Mrázek, 1891, Tab. VI, fig. 20.

PLATE X, FIGS. 112–124*b*.—*Drepanidotænia anatina* and *Drepanidotænia sinuosa.*

[Figs. 112–115. *Drepanidotænia anatina.*]

Fig. 112. Cysticercoid with anterior portion of the tail: *rm.*, circular muscles; *p.*, (third), parenchymatic layer; *h.*, fourth layer = neck; *hr.*, posterior rostellum sac; *r.*, rostellum; *ex.*, excretory system. After Schmidt, 1894, Taf. VI, Fig. A.

Fig. 113. Cysticercoid with anterior portion of the tail: *h.*, peripheral layer; *ku.*, cuticle; vl^1., muscular fibers; pch^1., parenchymatic layer; vl^2., second layer of fibers; pch^2., internal parenchymatic layer (= neck) with calcareous corpuscles (*v*); *e.*, excretory apparatus; *pr.*, caudal appendage; *j.*, nuclei of cells in the tail; *hc.*, hooks of oncosphere. Zeiss 3, D. After Mrázek, 1891, Tab. VI, fig. 19.

Fig. 114. Isolated young hook. After Mrázek, 1891, Tab. VI. fig. 21.

Fig. 115. Ten hooks taken from the outline of cyst of cysticercoid, showing the hooks in position on the rostellum. After Mrázek, 1891, Tab. VI, fig. 22.

[Figs. 116–124*b*. *Drepanidotænia sinuosa.*]

Fig. 116. A young worm, natural size. After Zeder, 1800, Tab. III, fig. 5.

Fig. 117. Distal end of a young worm enlarged: *a*, *b*, two knobs. After Zeder, 1800, Tab. III, fig. 6.

Fig. 118. An adult worm, natural size. After Zeder, 1800, Tab. III, fig. 7.

Fig. 119. Short segments enlarged. After Zeder, 1800, Tab. III, fig. 8.

Fig. 120. Scolex enlarged: *f*, the long rostellum with hooks; *c c*, *d d*, suckers; *a a*, *b b*, neck. After Zeder, 1800, Tab. III, fig. 9.

Fig. 121. Two large segments, enlarged: *a a*, *b b*, the "vermiform sacs;" *c c*, cirri; *d*, posterior corners of the segments. After Zeder, 1800, Tab. III, fig. 10.

Fig. 122. Isolated eggs, enlarged. After Zeder, 1800, Tab. III, fig. 11.

Fig. 123. Rostellum of *Drep. sinuosa*. x240. After Krabbe, 1869, Tab. VII, fig. 151.

Fig. 124. Two isolated hooks. x920. *a*, from a parasite in the domesticated duck; *b*, from a parasite in the mallard. After Krabbe, 1869, Tab. VII, fig. 152*a–b*.

PLATE XI, FIGS. 125–139.—*Drepanidotænia sinuosa.*

Fig. 125. Segment with genital organs and extruded cirrus. x35. After Krabbe, 1869, Tab. VII, fig. 153.

Fig. 126. Bloch's original figure of "*Tænia collari nigro,*" from the domesticated duck; possibly identical with *Drep. sinuosa.* After Bloch, 1782, Taf. IV, fig. 11.

Fig. 127. Anterior portion of the same, enlarged. After Bloch, 1782, Taf. IV, fig. 12.

Fig. 128. Segments from the middle of the same, enlarged. After Bloch, 1782, Taf. IV, fig. 13.

Fig. 129. Cirrus. x210. After Dujardin, 1845, Pl. 9, Fig. D. Host: Goose.

Fig. 130. A *Cyclops viridis* containing 3 cysticercoids of *Drep. sinuosa: vc.*, eggs. Zeiss 3, A. After Mrázek, 1891, Tab. V, fig. 7.

Fig. 131. Isolated cysticercoid, to show the proportional sizes of the cyst and the tail. Zeiss 3, A. After Mrázek, 1891, Tab. V, fig. 8.

Fig. 132. Isolated hook, greatly enlarged. Zeiss 3, F. After Mrázek, 1891, Tab. V. fig. 10.

Fig. 133*a–c*. Young stages of hooks. Zeiss 3, F. After Mrázek, 1891, Tab. V, fig. 11.

Fig. 134. Two isolated hooks of a cysticercoid which otherwise corresponds in form to *Drep. sinuosa.* The form and size (35 μ) of these hooks resemble those of *Drep. setigera.* Zeiss 3, F. After Mrázek, 1891, Tab. V, fig. 12.

Fig. 135. Cysticercoid with anterior portion of tail, drawn from life. Zeiss 3, D. After Mrázek, 1891, Tab. V, fig. 9.

Fig. 136. Two isolated hooks from fully developed scolex of cysticercoid. Zeiss 3, F. After Hamann, 1889, Taf. I, fig. 9.

Fig. 137. The 10 hooks of the rostellum in position. Zeiss 3, F. After Hamann, 1889, Taf. I, fig. 10.

Fig. 138. Calcareous corpuscles from the parenchyma of the scolex. Zeiss 3, F. After Hamann, 1889, Taf. I, fig. 11.

Fig. 139. A hook of the oncosphere from the tail of a cysticercoid. After Hamann, 1889, Taf. I, fig. 12.

PLATE XII, FIGS. 140–152.—*Drepanidotænia sinuosa, Drepanidotænia setigera,* and *Tænia Krabbei* Kowalewski *nec* Moniez.

[Figs. 140–146. *Drepanidotænia sinuosa.*]

Figs. 140–142. Three successive stages in the development of the cysticeroid in *Gammarus pulex.* Zeiss 1, A. After Hamann, 1889, Taf. I, figs. 4, 5, 6.

Fig. 143. Median longitudinal section through fig. 140. Zeiss 4, A. After Hamann, 1889, Taf. I, fig. 7.

Fig. 144. Median longitudinal section through a stage nearly corresponding to fig. 142. Zeiss 4, A. After Hamann, 1889, Taf. I, fig. 8.

Fig. 145. Fully developed cysticercoid, surrounded by its tail, *s*, and a cyst *h*. Zeiss 3, A. After Hamann, 1889, Taf. I, fig. 1.

Fig. 146. The same without surrounding cyst. Zeiss 3, A. After Hamann, 1889, Taf. I, fig. 3.

[Figs. 147–150. *Drepanidotænia setigera.*]

Fig. 147. Scolex with 6 of the 10 hooks. x240. After Krabbe, 1869, Tab. VI, fig. 117. Host: Domesticated goose.

Fig. 148. Isolated hook of same. x920. After Krabbe, 1869, Tab. VI, fig. 118.

Fig. 149. Isolated hook from Rudolphi's 1819, p. 700B, "*Tænia sinuosa*" = *Drep. setigera.* x920. After Krabbe, 1869, Tab. VI, fig. 120.

Fig. 150. Cirrus. x240. After Krabbe, 1869, Tab. VI, fig. 119.

[Figs. 151–152. *Tænia Krabbei* Kowalewski nec Moniez.]

Fig. 151. Two isolated hooks of a tapeworm, which Krabbe (1869, p. 290) found in a goose and determined as "*T. setigera?;*" this form has since been described as *T. Krabbei* by Kowalewski, 1895. x920. After Krabbe, 1869, Tab. VI, fig. 121.

Fig. 152. Two isolated hooks from *T. Krabbei* Kowalewski, 1895 [nec Moniez, 1879.] x1000. After Kowalewski, 1895, Tab. VIII, fig. 27.

PLATE XIII, FIGS. 153–164.—*Drepanidotænia sinuosa* and *Drepanidotænia setigera.*

Fig. 153. *Drepanidotænia sinuosa.* Cysticercoid with anterior portion of tail: *a, b, c, d,* layers of the cuticle. Glycerine preparation. Zeiss I, D. After Hamann, 1889, Taf. I, fig. 2. Host: *Gammarus pulex.*

[Figs. 154–164. *Drepanidotænia setigera.*]

Fig. 154. Adult worm, natural size. After Frölich, 1789, Tab. IV, fig. 1.

Fig. 155. Head of same, enlarged, with (*a*) rostellum and (*b*) suckers. After Frölich, 1789, Tab. IV, fig. 2.

Fig. 156. Three young segments of same, greatly enlarged. After Frölich, 1789, Tab. IV, fig. 3.

Fig. 157. Six segments from posterior end, enlarged, with (*a*) extruded or (*b*) partly extruded cirri. After Frölich, 1789, Tab. IV, fig. 4.

Figs. 158–160. Three isolated segments with genital organs: *a,* cirrus pouch; *c,* testicles; *e,* vas deferens with vesicula seminalis; *g,* vagina; *i,* vitellogene gland; *k,* ovary; *m,* receptaculum seminis. After Feuereisen, 1868, Taf, X, figs. 14, 15, 16, of "*Tænia fasciata.*"

Fig. 161. Hook from scolex. After Feuereisen, 1868, Taf. X, fig. 3.

Fig. 162. Transverse section of segment: *p.,* cirrus; *v.,* vagina; *l. m.,* longitudinal muscles; *k.,* excretory (longitudinal) canals; *ov.,* ovary. Hartnack 2, 2. After Lönnberg, 1889, Taf. I, fig. 7.

Fig. 163. Cysticercoid, with very long tail, from *Cyclops brevicaudatus.* After von Linstow, 1892B, fig. 1.

Fig. 164. Hook from the same. After von Linstow, 1892, fig. 2.

PLATE XIV, FIGS. 165–186.—*Drepanidotænia tenuirostris* and *Drepanidotænia infundibuliformis.*

[Figs. 165–172. *Drepanidotænia tenuirostris.*]

Fig. 165. Cysticercoid with tail. x325. After Hamann, 1889, Fig. A. From the body cavity of *Gammarus pulex.*

Fig. 166. Calcareous corpuscles of same. x800. After Hamann, 1889, Fig. B.

Fig. 167. Hooks from the rostellum. x800. After Hamann, 1889, Fig. C.

Fig. 168. Cysticercoid with long tail. Zeiss 3, A. After Mrázek, 1891, Tab. V, fig. 3.

Fig. 169. Cysticercoid with anterior portion of tail. Zeiss 3, D. After Mrázek, 1891, Tab. V, fig. 4.

Fig. 170. Two hooks of same. Zeiss 3, F. After Mrázek, 1891, Tab. V, fig. 5.

Fig. 171. The same, greatly magnified. After Mrázek, 1891, Tab. V, fig. 6.

Fig. 172. Very young stage of cysticercoid of *Drep. tenuirostris* (?). The oncospheric hooks are preserved. After Mrázek, 1891, Tab. VI, fig. 24.

[Figs. 173–186. *Drepanidotænia infundibuliformis.*]

Fig. 173. Goeze's original figure of worm, natural size. After Goeze, 1782, Tab. XXXI, A, fig. 1.

Fig. 174. Head of same, enlarged, showing hooks and suckers. After Goeze, 1782, Tab. XXXI, A, fig. 2.

Fig. 175. Posterior segments, enlarged. After Goeze, 1782, Tab. XXXI, A, fig. 3.

Fig. 176. Posterior segments with eggs, enlarged. After Goeze, 1782, Tab. XXXI, A, fig. 4.

Fig. 177. Eggs, enlarged. After Goeze, 1782, Tab. XXXI, A, fig. 5.

Fig. 178. An inverted piece of chicken's intestine, with numerous tapeworms attached. After Goeze, 1782, Tab. XXXI, A, fig. 6.

Fig. 179. Scolex with hooks. x240. After Krabbe, 1869, Tab. X, fig. 287.

Fig. 180*a–c*. Three isolated hooks. x920. Fig. 180*c* from Küchenmeister's collection. After Krabbe, 1869, Tab. X, fig. 288*a–c*.

Fig. 181. Cirrus. x240. After Krabbe, 1869. Tab. X, fig. 289.

Fig. 182. Egg. x240. After Krabbe, 1869, Tab. X, fig. 290.

Fig. 183. Head of "*T. infundibulum.*" x80. After Cobbold, 1859, Pl. LXIII, fig. 25.

Fig. 184. Rostellum. After Crety, 1890, fig. 5.

Fig. 185. Isolated hooks. After Crety, 1890, fig. 6.

Fig. 186. Mature egg. After Crety, 1890, fig. 8.

PLATE XV, FIGS. 187–198.—*Drepanidotænia infundibuliformis* and *Davainea proglottina.*

[Figs. 187–193. *Drepanidotænia infundibuliformis.*]

Fig. 187. Bloch's "*Tænia articulis convideis.*" After Bloch, 1782, Tab. III, fig. 1.

Fig. 188. Head of same, enlarged. After Bloch, 1782, Tab. III, fig. 2.

Fig. 189. Transverse section of mature proglottid. After Crety, 1890, fig. 15.

Fig. 190. Part of a longitudinal section of the larval stage from the body cavity of a fly: *cav.*, "cavity of the gastrula;" *lac.*, "primitive cavity;" *sco.*, scolex; *ven.*, sucker. Koritska 3, 8. After Grassi & Rovelli, 1892, Tav. IV, fig. 14.

Fig. 191. Cysticercoid partly extended: *par. int.*, internal wall; *par. est.*, external wall; *sco.*, scolex. Koritska, 3, 4. After Grassi & Rovelli, 1892, Tav. IV, fig. 15.

Fig. 192. Anterior extremity of fig. 191. Koritska, 3, 8. After Grassi & Rovelli, 1892, fig. 16.

Fig. 193. Segments from Rudolphi's specimen of "*Tænia infundibuliformis*" in *Otis tarda.* After Krabbe, 1868, Tab. III, fig. 5. See text p. 44.

[Figs. 194–198. *Davainea proglottina.*]

Fig. 194. Adult worm: *g.*, ovary; *p.*, cirrus pouch; *r.*, receptaculum seminis; *t.*, testicle; *v.*, vagina; *vi.*, vitellogene gland. x95. After R. Blanchard, 1891B, fig. 4.

Fig. 195. Head of same with extended rostellum and one partly detached segment. After R. Blanchard, 1891B, fig. 5.

Fig. 196. Head with retracted rostellum; the first segment is forming from the neck. After R. Blanchard, 1891B, fig. 6.

Fig. 197*a–b*. Three isolated hooks: *a*, from rostellum; *b*, from suckers. After R. Blanchard, 1891B, fig. 7.

Fig. 198. Isolated egg. After R. Blanchard, 1891B, fig. 8.

PLATE XVI, FIGS. 199–211.—*Davainea proglottina* and *Davainea circumvallata.*

[Figs. 199–202. *Davainea proglottina.*]

Fig. 199. Cysticercoid, in which the oncospheric hooks are still visible: *ros.*, rostellum; *ven.*, suckers; Koritska 3, 8. After Grassi & Rovelli, 1892, Tav. IV, fig. 7. (Fresh specimen.)

Fig. 200. The same, preserved: *boc.*, opening of the cysticercoid; *cav.*, "cavity of the gastrula;" *lac.*, "primitive lacune;" *sco.*, scolex. Koritska, 3, 8. After Grassi & Rovelli, 1892, Tav. IV, fig. 8.

Fig. 201. Longitudinal section: *boc.*, opening of cysticercoid; *cav.*, "cavity of the gastrula;" *sco.*, scolex. Hartnack, 2, 7. After Grassi & Rovelli, 1892, Tav. IV, fig. 9.

Fig. 202. Young cysticercoid: *ven.*, sucker; *cod.*, tail. Koritska, 3, 5. After Grassi & Rovelli, 1892, Tav. IV, fig. 10.

[Figs. 203–211. *Davainea circumvallata.*]

Fig. 203. Ovum. x240. After Krabbe, 1869, Tab. X, fig. 295.

Fig. 204. Head and neck: *pr.*, rostellum; *r*, line of hooks; *v*, sucker; *c*, neck. After Crety, 1890, fig. 9.

Fig. 205. Hook from rostellum. After Crety, 1890, fig. 10.

Fig. 206. Ovum. After Crety, 1890, fig. 11.

Fig. 207. Frontal section of side of segment, through the cirrus pouch and vagina: *ci.*, cirrus; *va.*, vagina; *sg.*, genital sinus; *sb.*, cells of subcuticula. After Crety, 1890, fig. 12.

Fig. 208. Longitudinal section through egg sac: *m*, external capsule; *c*, granular content; *ov.*, ovum. After Crety, 1890, fig. 13.

Fig. 209. Scolex of "*T. pluriuncinata.*" x *ca.* 50. *a*, hook from rostellum; *b*, hook from sucker; *pr.*, rostellum; *v*, sucker; *s*, head; *c*, neck. After Crety, 1890, fig. 4.

Fig. 210. Ovum of same. After Crety, 1890, fig. 7.

Fig. 211. Frontal section of segment of same: *cl.*, ventral canal; *ct.*, transverse canal; *ur.*, egg sacs. After Crety, 1890, fig. 14.

PLATE XVII, FIGS. 212–227.—*Davainea cesticillus, Davainea echinobothrida,* and *Davainea tetragona.*

[Figs. 212–216. *Davainea cesticillus.*]

Fig. 212. Strobila. After Molin, 1861, Pl. VI, fig. 10.

Fig. 213. Anterior portion of same, and two posterior segments (middle portion of worm *ff*, omitted): *A*, head; *b*, ring surrounding the rostellum; *c*, rostellum; *d*, sucker; *E*, anterior portion of segmented body; *ff*, dotted line of omitted segments; *GG*, two posterior segments; *h*, extruded penis; *i*, vulva. After Molin, 1861, Pl. VI, fig. 11.

Fig. 214. Hook from rostellum of Dujardin's "*T. infundibuliformis* Gœze." x210. After Dujardin, 1845, Pl. IX, Fig. H, 2.

Fig. 215. Hook from rostellum. x920. After Krabbe, 1869, Tab. X, fig. 293.

Fig. 216. Ovum. x240. After Krabbe, 1869, Tab. X, fig. 294.

[Figs. 217–218. *Davainea echinobothrida.*]

Fig. 217. Strobila, natural size. After Mégnin, 1881A, Pl. V, fig. 1.

Fig. 218*a–d*. Head with appendages: *a*, head and neck; *b*, armature of suckers; *c*, hook from sucker; *d*, hook from rostellum. After Mégnin, 1881A, Pl V, fig. 2.

[Figs. 219–227. *Davainea tetragona.*]

Fig. 219. Head *D*, with rostellum (*a*) and suckers (*c*), followed by neck (*E*). Enlarged. After Molin, 1861, Tav. VII, fig. 6.

Fig. 220. Three posterior segments *A*, showing genital pores (*c*) and egg sacs (*b*). Enlarged. After Molin, 1861, Tav. VII, fig. 7.

Fig. 221. Isolated egg sac with (*a*) transparent membrane; *b*, granular substance; *c*, embryo in ovum (*d*). Enlarged. After Molin, 1861, Tab. VII, fig. 8.

Figs. 222–223. Head and neck showing armed rostellum and armed suckers. x35. After Krabbe, 1882, Tab. II, figs. 55, 56. From material collected by Fedtschenko in Turkestan.

Fig. 224. Hook from rostellum of same. x920. After Krabbe, 1882, Tab. II, fig. 59.

Fig. 225. A segment showing two longitudinal canals, several testicles, vas deferens, cirrus pouch and genital pore. x35. After Krabbe, 1882, Tab. II, fig. 57.

Fig. 226. Posterior segment, showing genital pore and egg sacs. x35. After Krabbe, 1882, Tab. II, fig. 58.

Fig. 227. Female genital organs: *vg.*, vagina; *r s.*, receptaculum seminis; *bd. trsv.*, transverse collecting canal; *cl. ov.*, opening of the ovarian tubules; *c. s.*, seminal canal; *ovd. disc.*, descending oviduct; *glv.*, vitellogene gland; *vt. ld.*, vitello-duct; *ovd. asc.*, ascending oviduct; *sb. ovd.*, opening of the ascending oviduct; *sbo. vtld.*, opening of the vitello-duct; *ootp.*, ootyp with shell gland. After Diamare, 1893, fig. 4.

PLATE XVIII, Figs. 228–246.—*Davainea tetragona*, *Davainea Friedbergeri* and *Davainea crassula.*

[Figs. 228–235. *Davainea tetragona.*]

Figs. 228–229. Supposed larvæ of "*Tænia bothrioplitis*" (=*Davainea tetragona*) from a snail (*Helix*). Treated with acetic acid. After Piana, 1882, Figs. F, 8, A., and F, 8, B., reduced. .

Fig. 230. Piece of the intestine of a fowl showing the nodules (reduced one-third). After Moore, 1895, fig. 1*a*.

Fig. 231. The mucosa of the intestine showing ulcerated areas; also several small and one larger tapeworm attached to the intestine (reduced one-third). After Moore, 1895, fig. 1*b*.

Fig. 232. A cross section of the intestine illustrating the thickening of the wall, due to a large number of the nodules; also a portion of a tapeworm which has penetrated the mucous membrane (enlarged). After Moore, 1895, fig. 1*c*.

Fig. 233. A cross section of a nodule containing a sequestrum situated in the outer or longitudinal muscular layer (circular layer of the muscular wall not affected). After Moore, 1895, fig. 2*a*.

Fig. 234. A section showing a tapeworm and a necrotic mass within the muscular wall. After Moore, 1895, fig. 2*b*.

Fig. 235. A portion of a cross section of the intestine showing the head of a tapeworm within the muscle and one lying between the villi with its head resting on the basement membrane of the mucosa. Enlarged. After Moore, 1895, fig. 2c.

[Figs. 236–242. *Davainea Friedbergeri.*]

Fig. 236. Hook from rostellum. After Friedberger, 1877, fig. 1.

Fig. 237. Hooks from the suckers. After Friedberger, 1877, fig. 2.

Fig. 238. Hook of oncosphere. After Friedberger, 1877, fig. 3.

Fig. 239. "*T. infundibuliformis* var. *phasiarum*," seu "*T. agama*"=? *Davainea Friedbergeri*. Natural size. After Mégnin, 1878, Pl. IV, fig. 1.

Fig. 240. View of head of same, *en face*, showing armed rostellum and 4 armed suckers. x120. After Mégnin, 1878, Pl. IV, fig. 3.

Fig. 241. Hook from rostellum of same. x725. After Mégnin, 1878, Pl. IV, fig. 4.

Fig. 242. Segments of same species. x20. After Mégnin, 1878, Pl. IV, fig. 4.

[Figs. 243–246. *Davainea crassula.*]

Fig. 243. "Eggs" (=Egg sacs) magnified. After Rudolphi, 1819, Tab. III, fig. 19.

Fig. 244. Hook from rostellum. x920. After Krabbe, 1869, Tab. X, fig. 301. From Rudolphi's original specimens.

Fig. 245. Anterior end of worm, showing rostellum and two suckers. x35. After Krabbe, 1882, Tab. II, fig. 66. From material collected in Turkestan by Fedtschenko.

Fig. 246. Hook from rostellum of same. x920. After Krabbe, 1869, Tab. II, fig. 67.

PLATE XIX, FIGS. 247-255.—*Echinocotyle Rosseteri* and *Ophryocotyle proteus.*

[Figs. 247-251. *Echinocotyle Rosseteri.*]

Fig. 247. Strobila. x120. After R. Blanchard, 1891B, fig. 1.
Fig. 248, Head with extended rostellum. x500. After R. Blanchard, 1891B, fig. 2.
Fig. 249*a*-*b*. Hooks: *a*, from rostellum, x400; *b*, from sucker, x2,500. After R. Blanchard, 1891B, fig. 3.
Fig. 250. Isolated segment: 1, evaginated cirrus with spines; 2, genital tubercle; 3, orifice of same with sphincter; 4, cirrus pouch, with ring of minute sharp spines; 5, seminal canal; 6, mass of spermatozoa. x600. After Rosseter, 1892, Pl. XXIII, fig. 8.
Fig. 251. Cysticercoid taken from the body cavity of *Cypris cinerea; a*, hooks on rostellum; *b*, hooks on suckers. x360. After Rosseter, 1892, Pl. XXII, fig. 1.

Figs. 252-255. *Ophryocotyle proteus.* After Friis, 1869, taken from R. Blanchard, 1891B, fig. 20.

Fig. 252. Strobila.
Fig. 253. Head and neck with retracted infundibulum.
Fig. 254. Head and neck with extended infundibulum.
Fig. 255. Sucker with armature.

PLATE XX, FIGS. 256-269.—*Tænia cantaniana, Tænia Delafondi, Tænia imbutiformis, Tænia megalops,* and *Tænia nigropunctata.*

Fig. 256. *Tænia cantaniana: a*, head; *b*, suckers; *c*, organ taken by Polonio for the "genital pore?"; *d*, well-developed eggs. After Polonio, 1860, Tav. VII, fig. 2.

[Figs. 257-262.—Mégnin's (1891, Figs. A-F.) figures of "*Tænia sphenocephala*" = Railliet's *Tænia Delafondi.*]

Fig. 257. Strobila natural size.
Fig. 258. Head and neck. x60.
Fig. 259. Three sexually active segments. x14.
Fig. 260. Egg. x375.
Fig. 261. Isolated oncosphere.
Fig. 262. Segmenting egg.

Fig. 263. *Tænia imbutiformis: a*, suckers; *b*., middle portion; *c*, caudal portion; *d*, "genital pores" (?). After Polonio, 1860, Tav. VII, fig. 3.

[Fig. 264-267.—*Tænia megalops* from Brazilian teal (*Anas braziliensis*). Coll. Vienna Museum.]

Fig. 264. Strobila natural size. Original.
Figs. 265-267. Three views of head, enlarged. Original.

[Figs. 268-270. *Tænia nigropunctata.* After Crety, 1890.]

Fig. 268. Head: *v*, sucker; *c*, neck. After Crety, 1890, fig. 3.
Fig. 269. Isolated segment: *l*, eggs; *m*, ovary; *p*, genital pore; *u*, uterus. After Crety, 1890, fig. 1.
Fig. 270. Egg with oncosphere. After Crety, 1890, fig. 2.

PLATE XXI, FIGS. 271-274.—*Tænia malleus, Idiogenes otidis* and *Tænia sp.* Conard, MS.

Fig. 271. *Tænia malleus*, head and anterior segments. After Goeze, 1782, Tab. XXX, fig. 3.

[Figs. 272–274. *Idiogenes otidis.*]

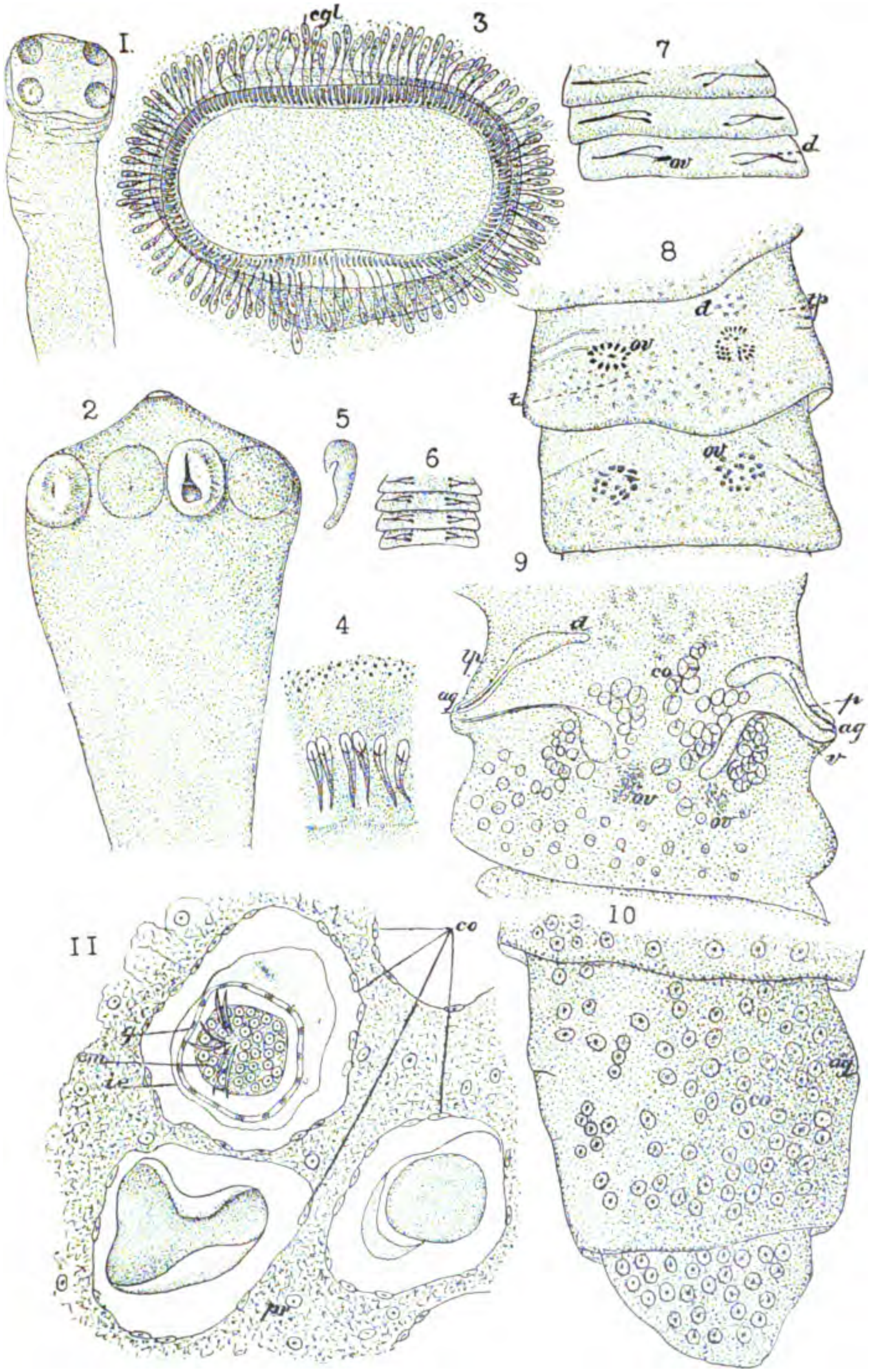
Fig. 272. Pseudoscolex and anterior portion of strobila. The first four segments form the pseudoscolex. After Zschokke, 1888, Pl. III, fig. 39.

Fig. 273. Segment with male and female organs: *cd.*, vas deferens; *c. e.*, vas efferens; *ci.*, cirrus; *t.*, testicles; *f. d. v.*, end of vagina (receptaculum seminis); *gl. g.*, ovary; *gl. v.*, vitellogene gland; *va.*, vagina. After Zschokke, 1888, Pl. III, fig. 42.

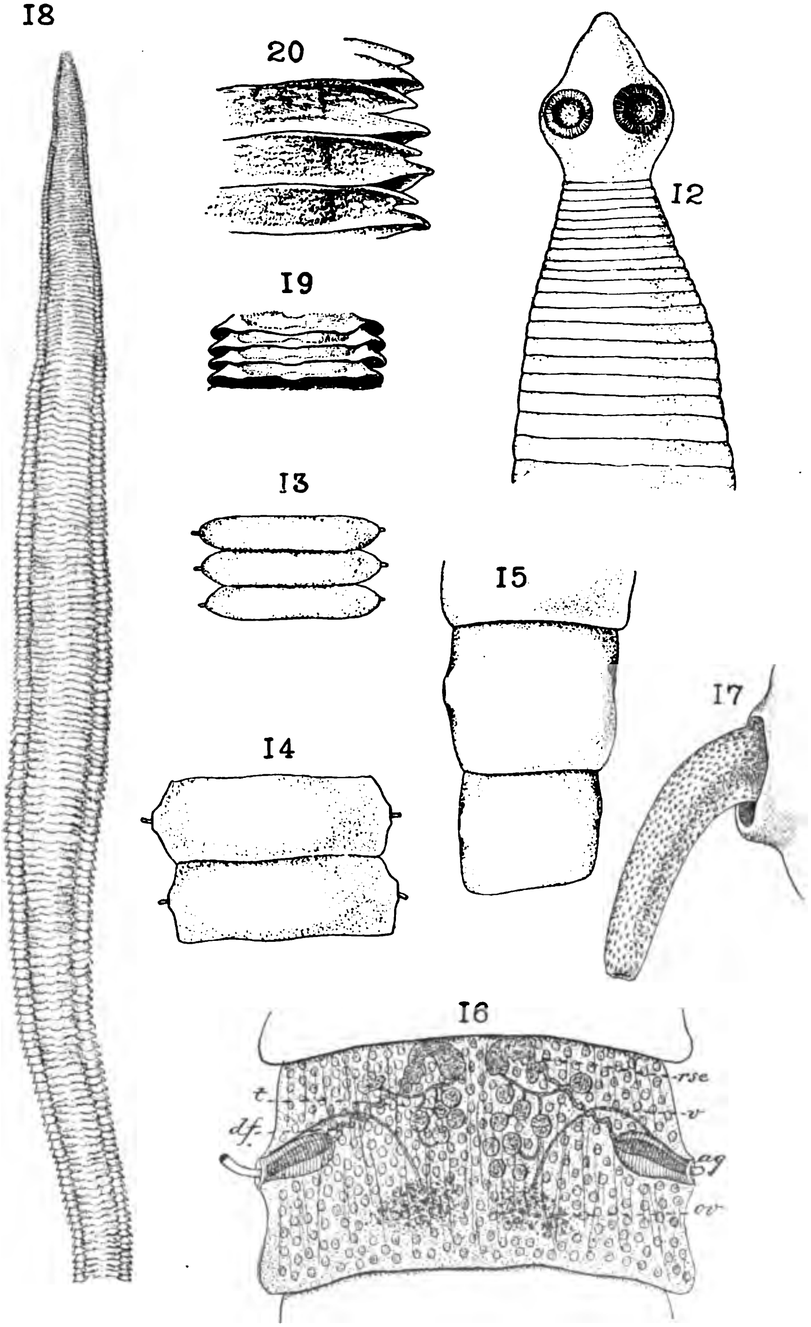
Fig. 274. Segment with developed uterus: *cap. ut.*, superior uterine cavity; *c. d.*, vas deferens; *p. d. c.*, cirrus pouch; *va.*, vagina. After Zschokke, 1888, Pl. III fig. 46.

[Figs. 275, 276. Two diagrams of *Tænia* sp. from chickens. After Conard, unpublished.]

Fig. 275. Dorsal view; fig. 276, transverse section: *n.*, nerve; *d. c.*, dorsal canal; *v. c.*, ventral canal; *t. c.*, transverse canal; *g. c.*, genital cloaca with pore; *c.*, cirrus; *c. p.*, cirrus pouch; *v. s.*, vesicula seminalis; *t.*, testicle; *ut.*, "probably uterus" (or testicle?); *v.*, vagina; *r. s.*, receptaculum seminis; *ov.*, probably ovary; *s. g.*, probably shell gland; *l. m.*, longitudinal muscles.

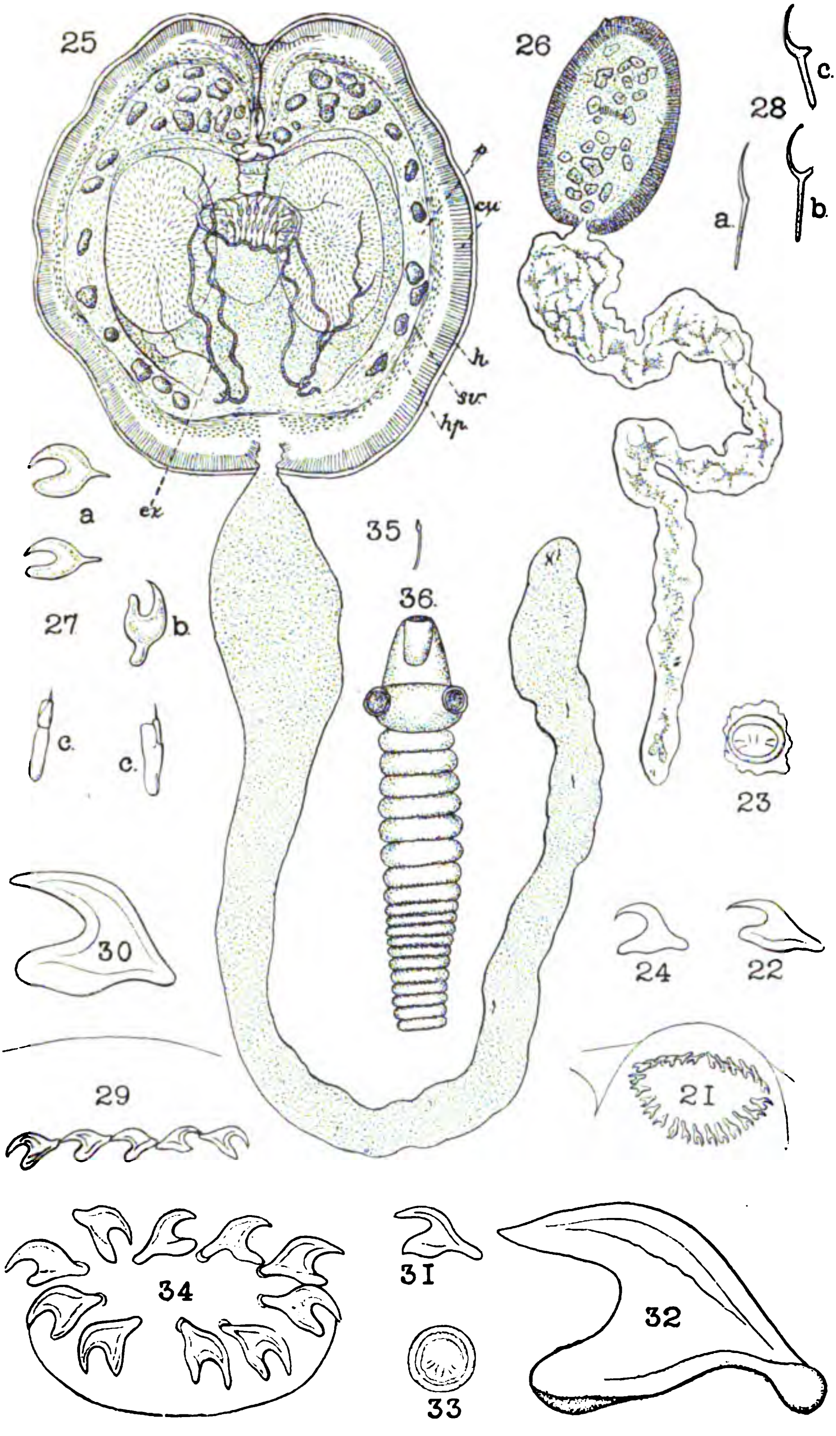


1-11. *Cotugnia digonopora.*



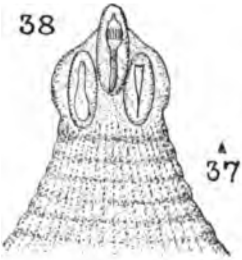
12-17. *Cotugnia bifaria.*

18-20. *Amabilia lamelligera.*

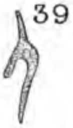


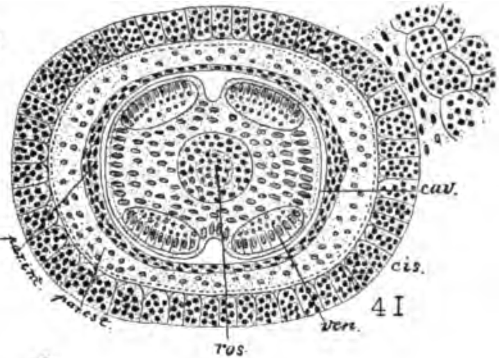
21–28. *Dicranotænia coronula.*
29–30. *Dicranotænia æquabilis.*
31–34. *Dicranotænia furcigera.*
35–36. *Tænia conica.*

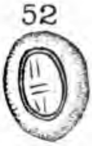
PLATE IV.

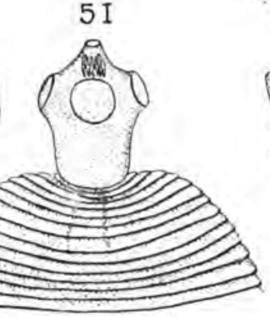

38

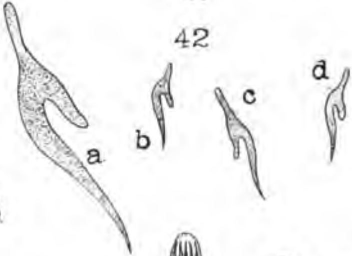
37

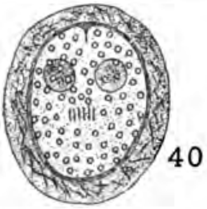

39

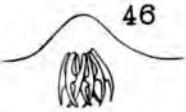

41

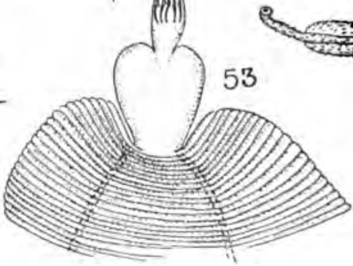

52

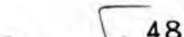

51

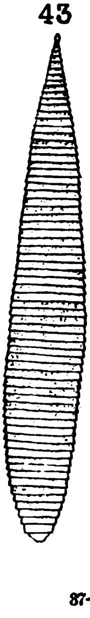

42

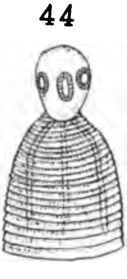

40

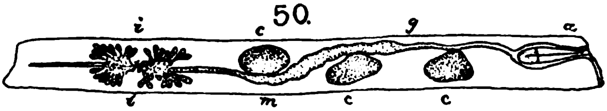

46

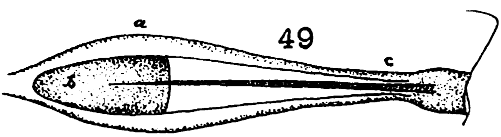

53

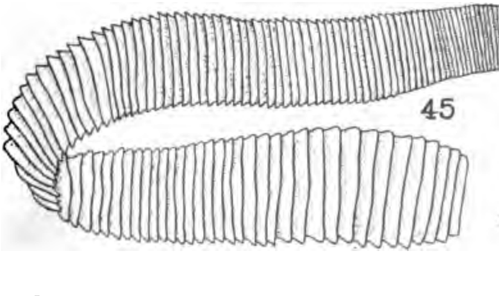

48

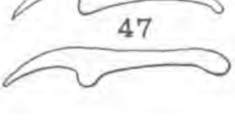

43


44

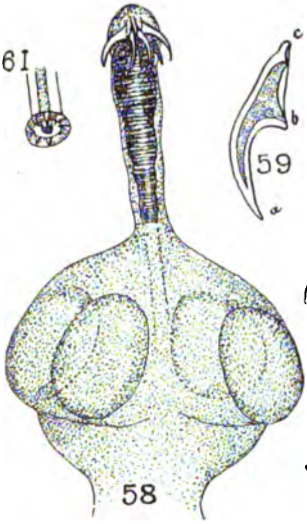

50.

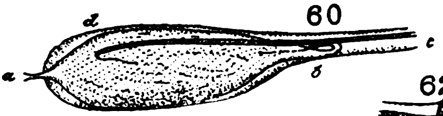

49

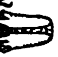

45

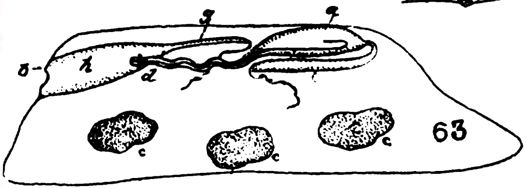

47

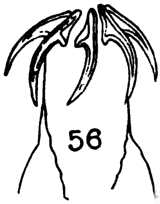
37-42. *Dicranotænia sphenoides.* 43-53. *Drepanidotænia lanceolata.*

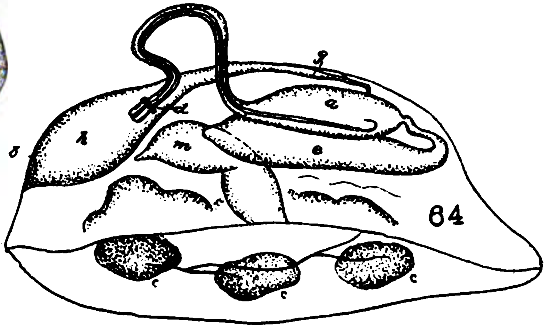


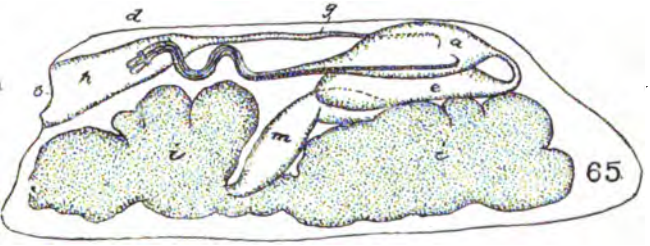


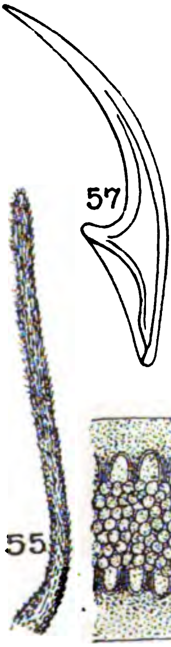


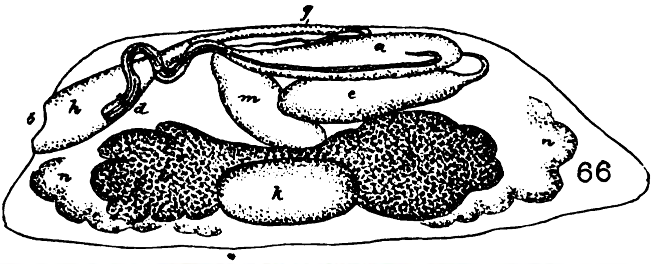


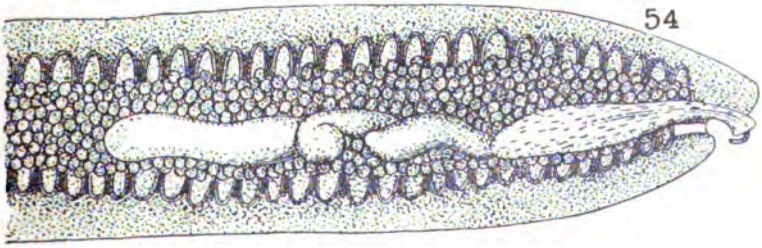






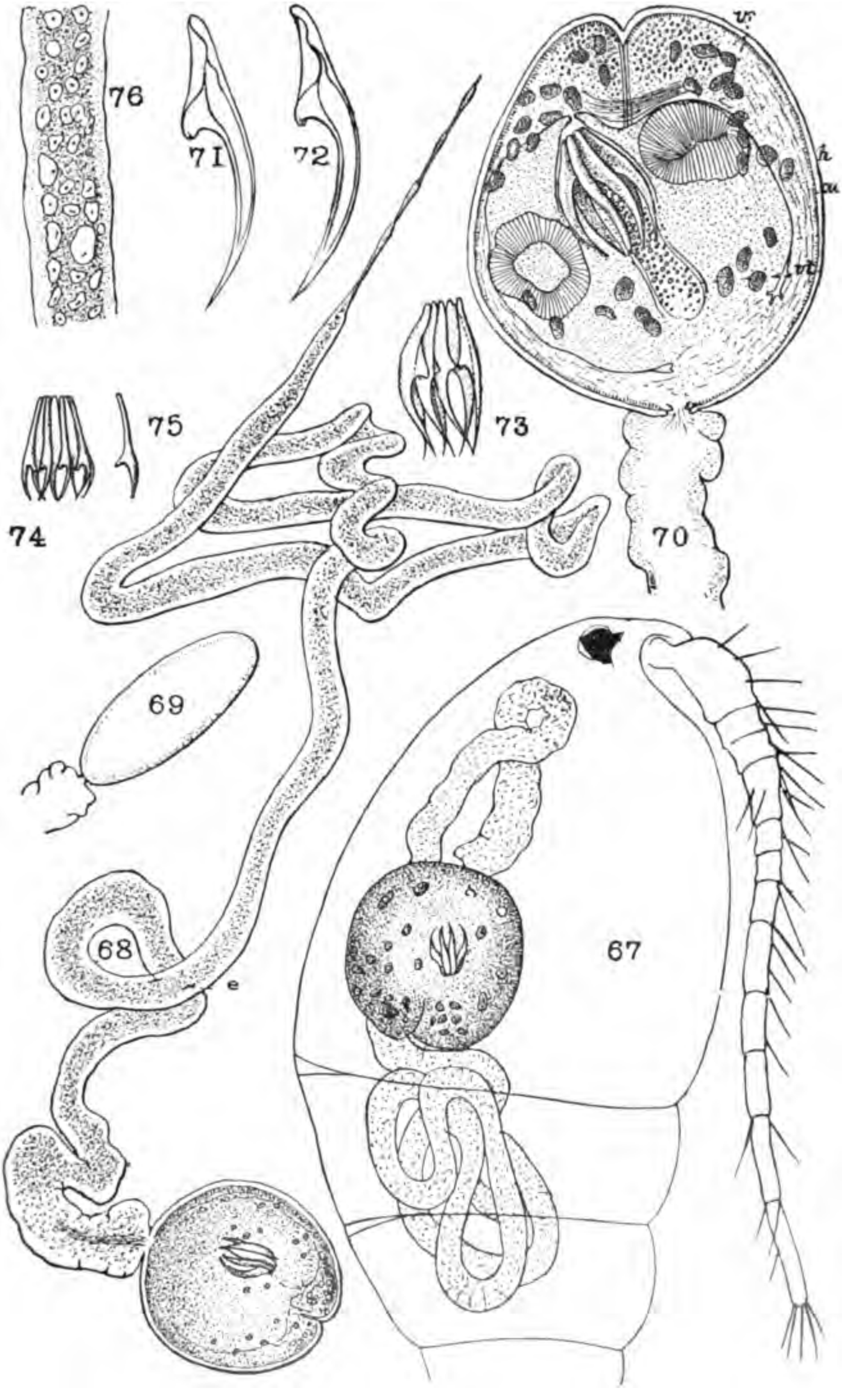






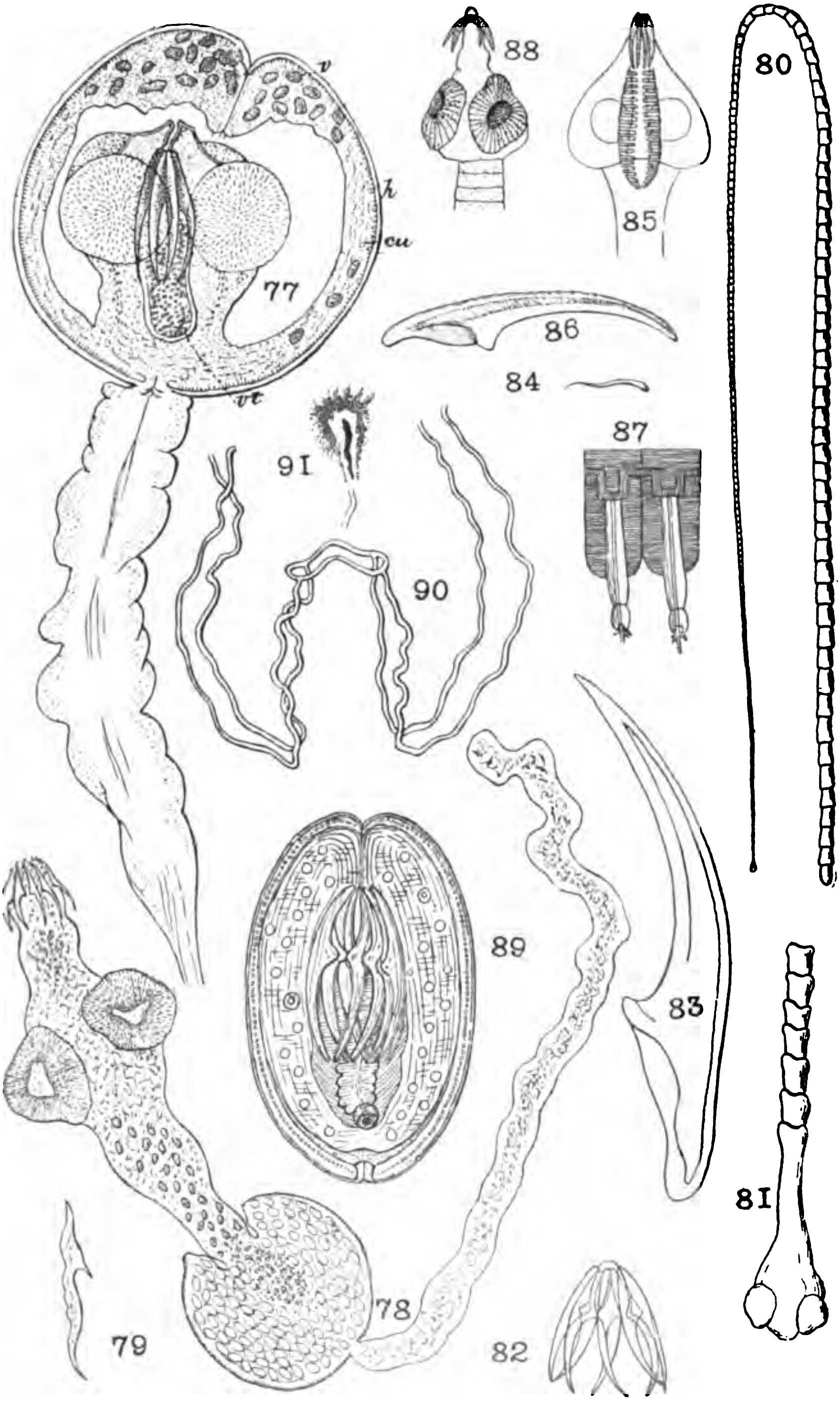
54-55. *Drepanidotænia lanceolata.*

56-66. *Drepanidotænia fasciata.*



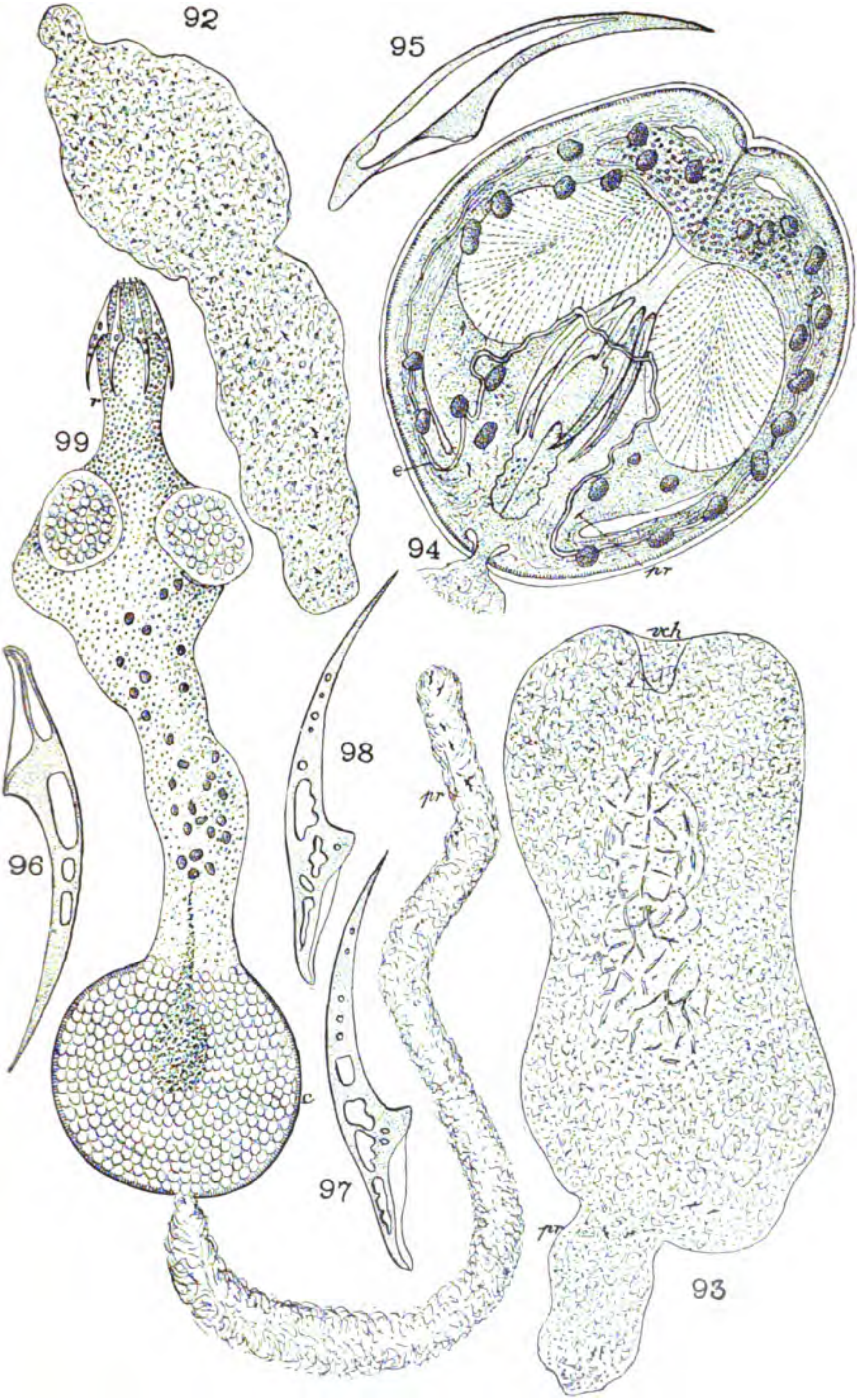
67-76. *Drepanidotænia fasciata.*

PLATE VII.

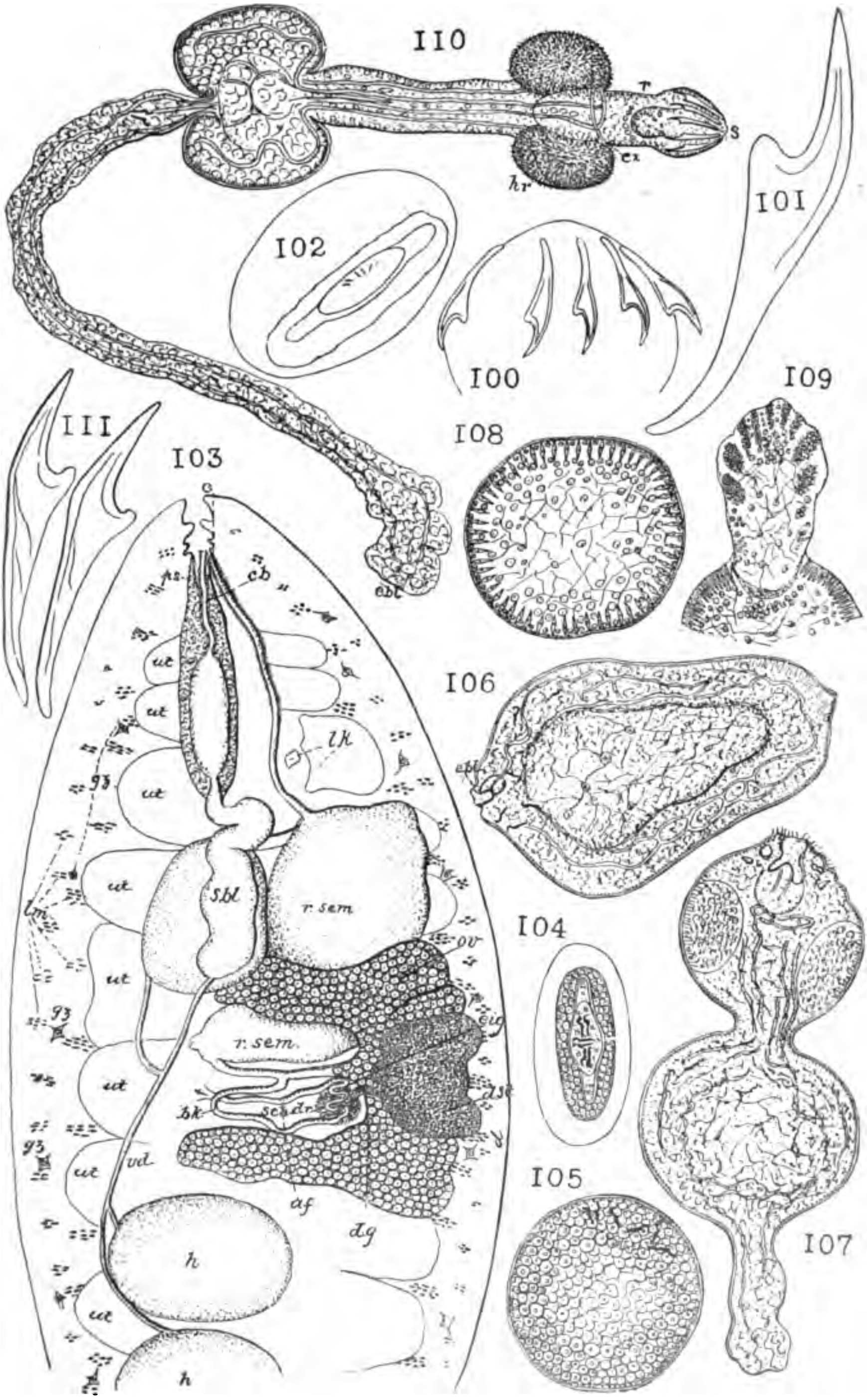


77–79. *Drepanidotænia fasciata.* 80–91. *Drepanidotænia gracilis.*

PLATE VIII.

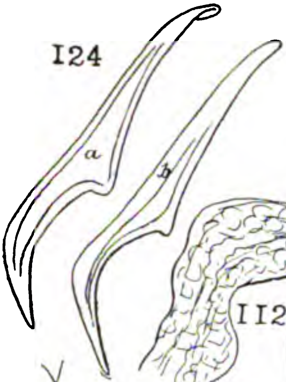


92–99. *Drepanidotænia gracilis.*

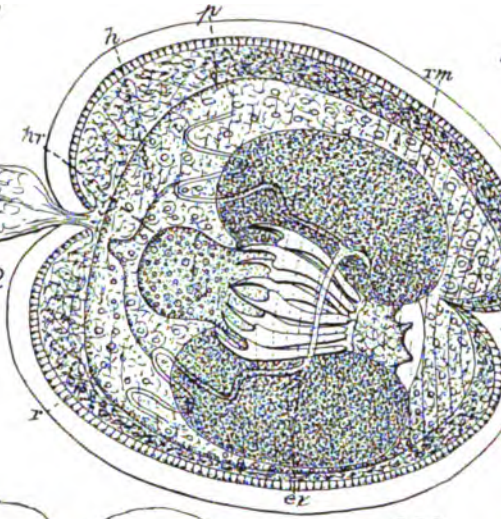


100-111. *Drepanidotænia anatina.*

PLATE X.

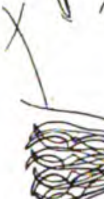


124



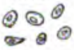
112

114

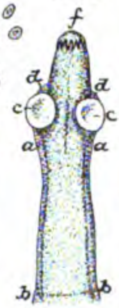


123

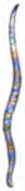
119



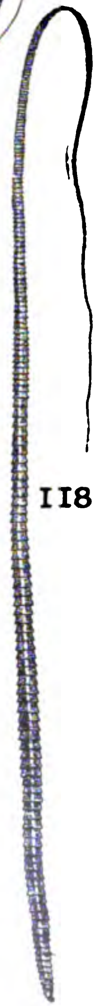
122



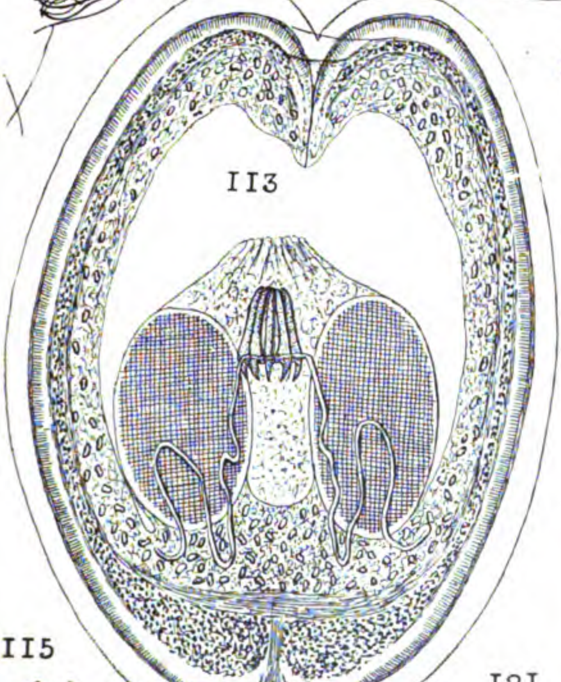
120



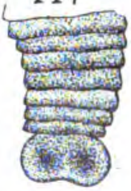
116



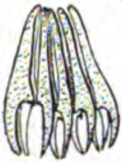
118



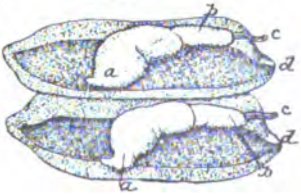
113



117



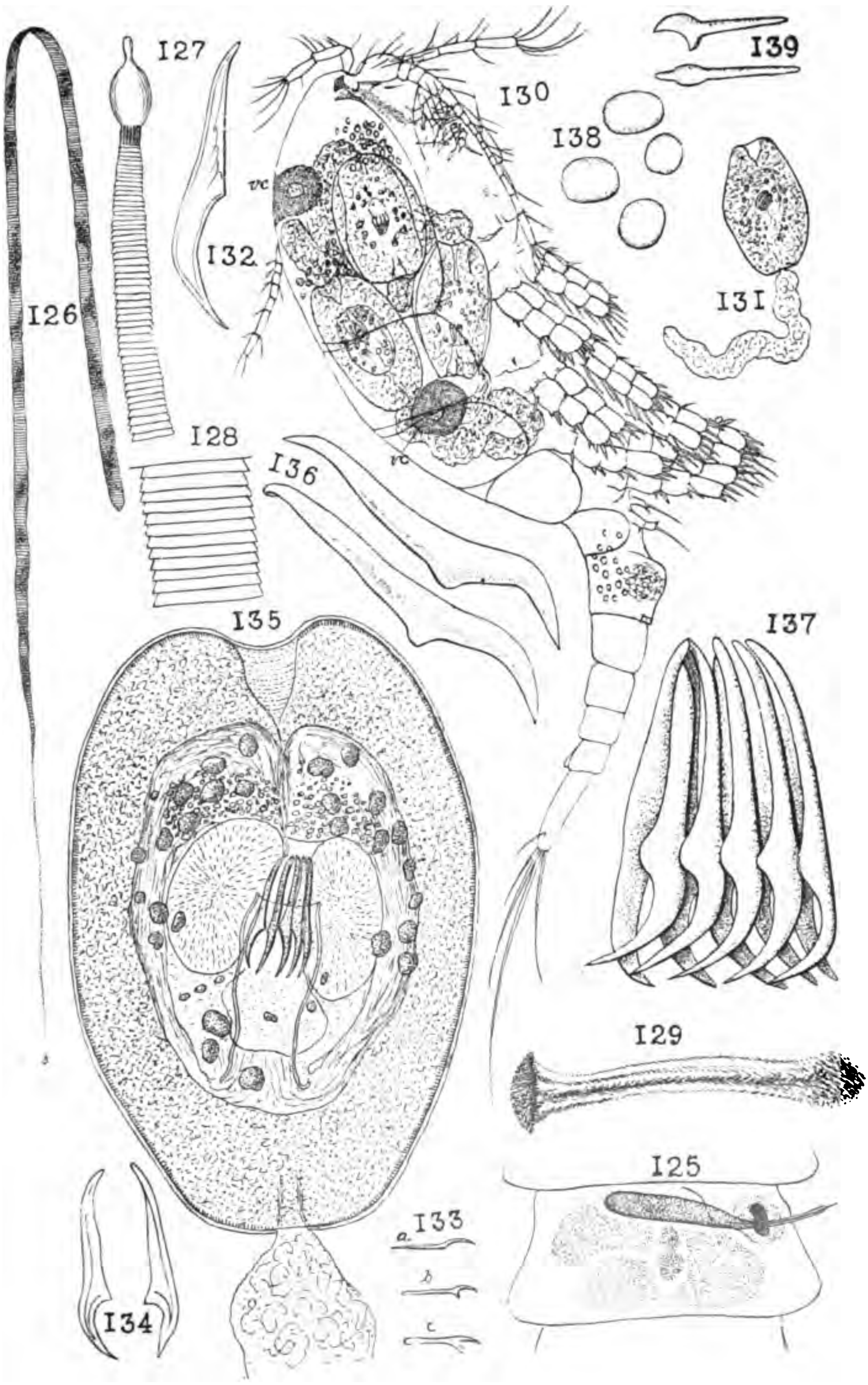
115



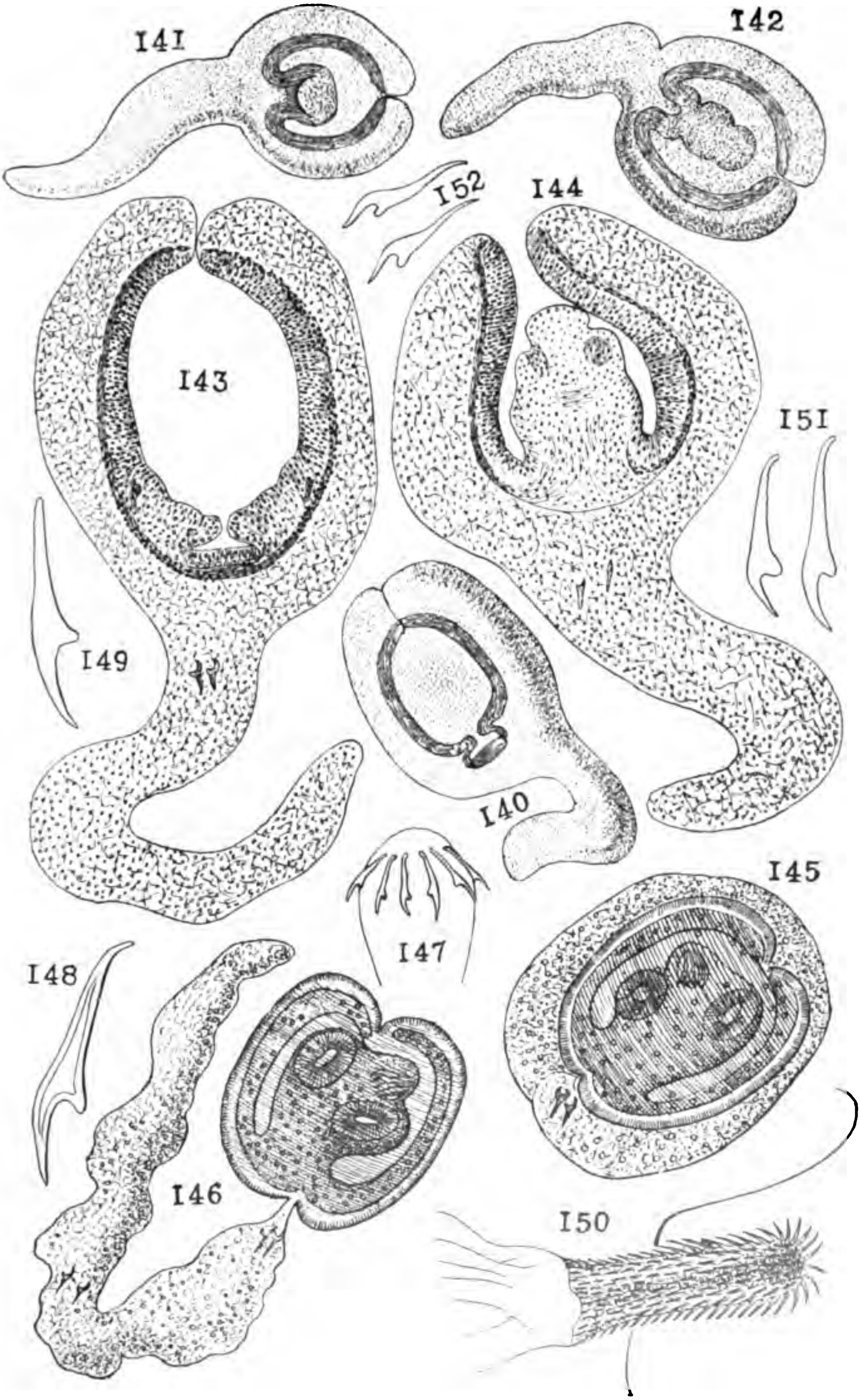
121

112–115. *Drepanidotænia anatina*.

116–124. *Drepanidotænia sinuosa*.

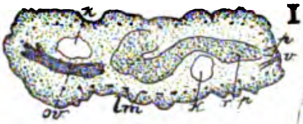


125–139. *Drepanidotænia sinuosa.*

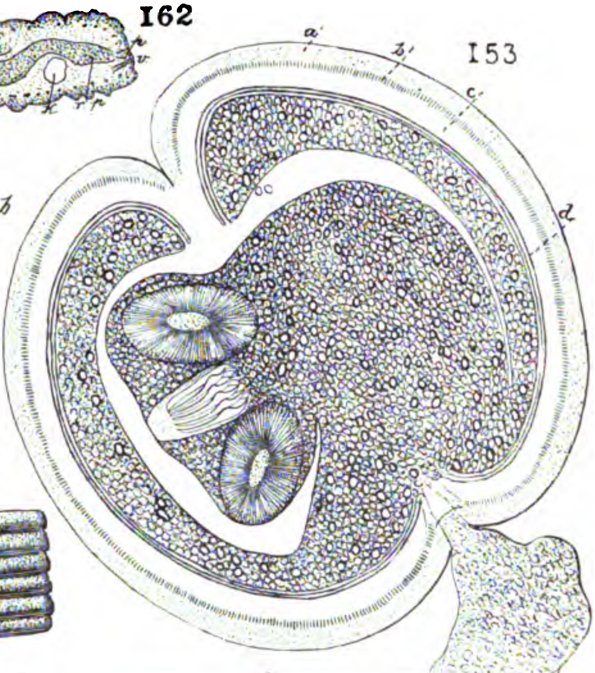


140–146. *Drepanidotænia sinuosa.* **147–150.** *Drepanidotænia setigera.*
151–152. *Tænia Krabbei* Kowalewski.

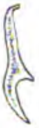
162



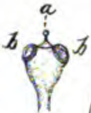
153



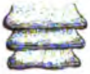
161



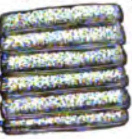
155



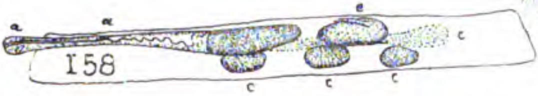
156



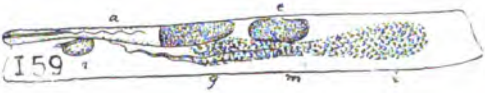
157



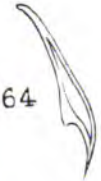
158



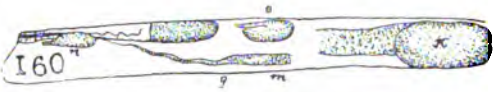
159



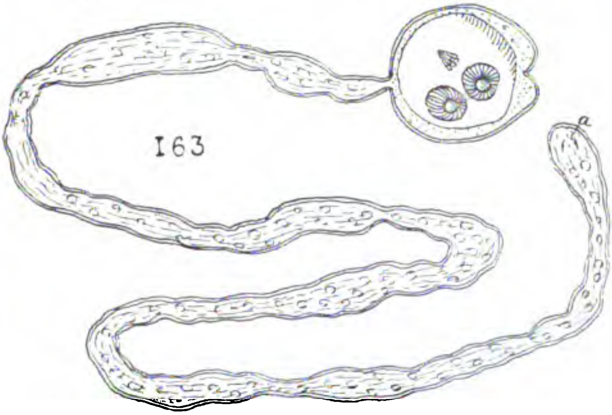
164

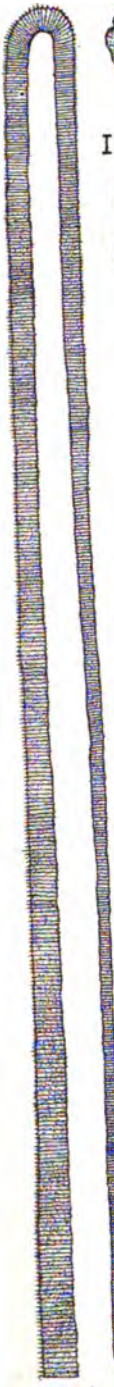


160



163



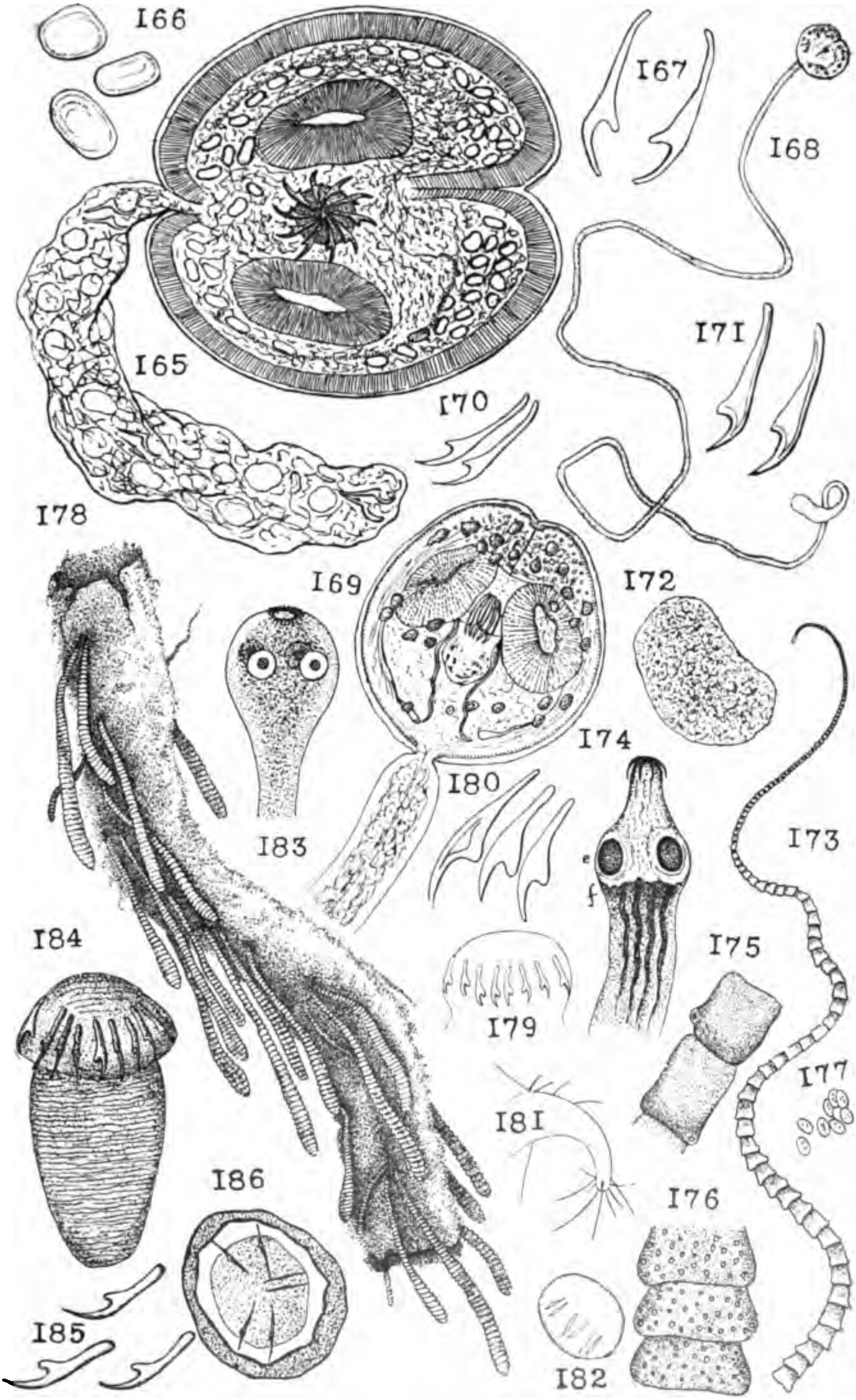


154

153. *Drepanidotænia sinuosa.*

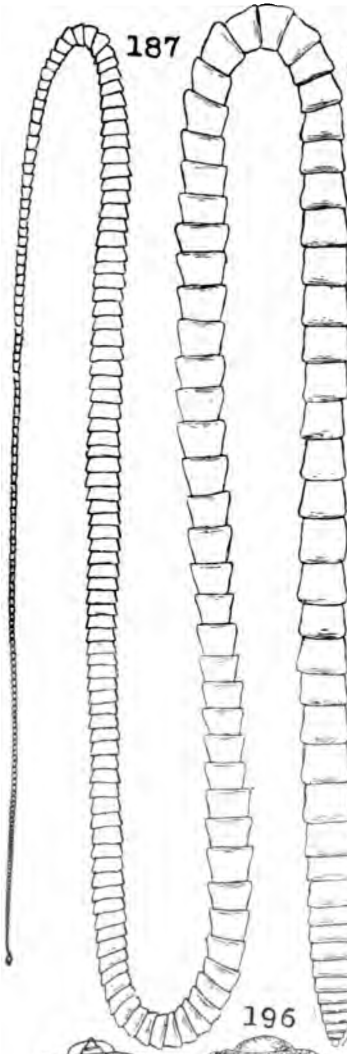
154–164. *Drepanidotænia setigera.*

PLATE XIV.

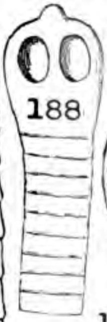


165–172. *Drepanidotænia tenuirostris.* 173–186. *Drepanidotænia infundibuliformis.*

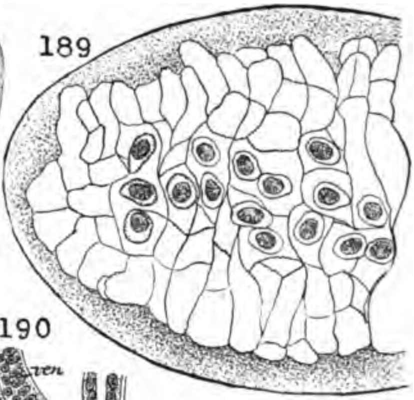
187



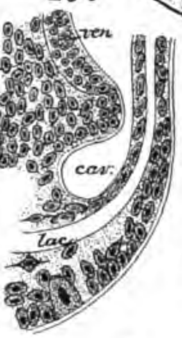
188



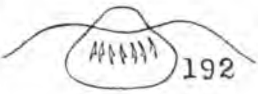
189



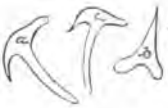
190



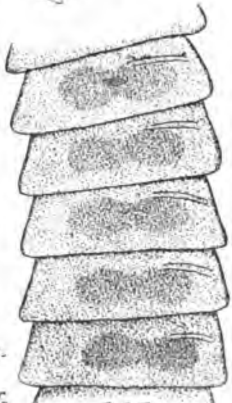
192



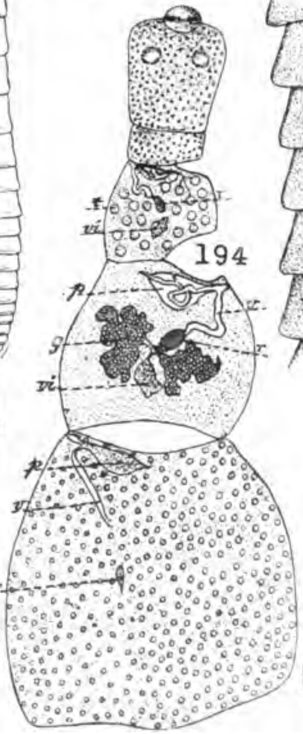
197



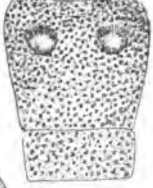
193



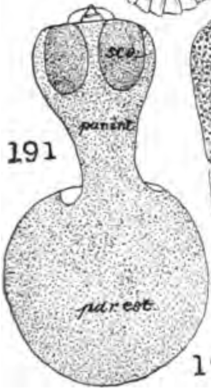
194



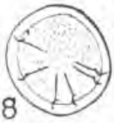
196



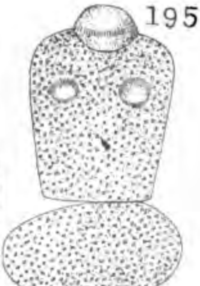
191



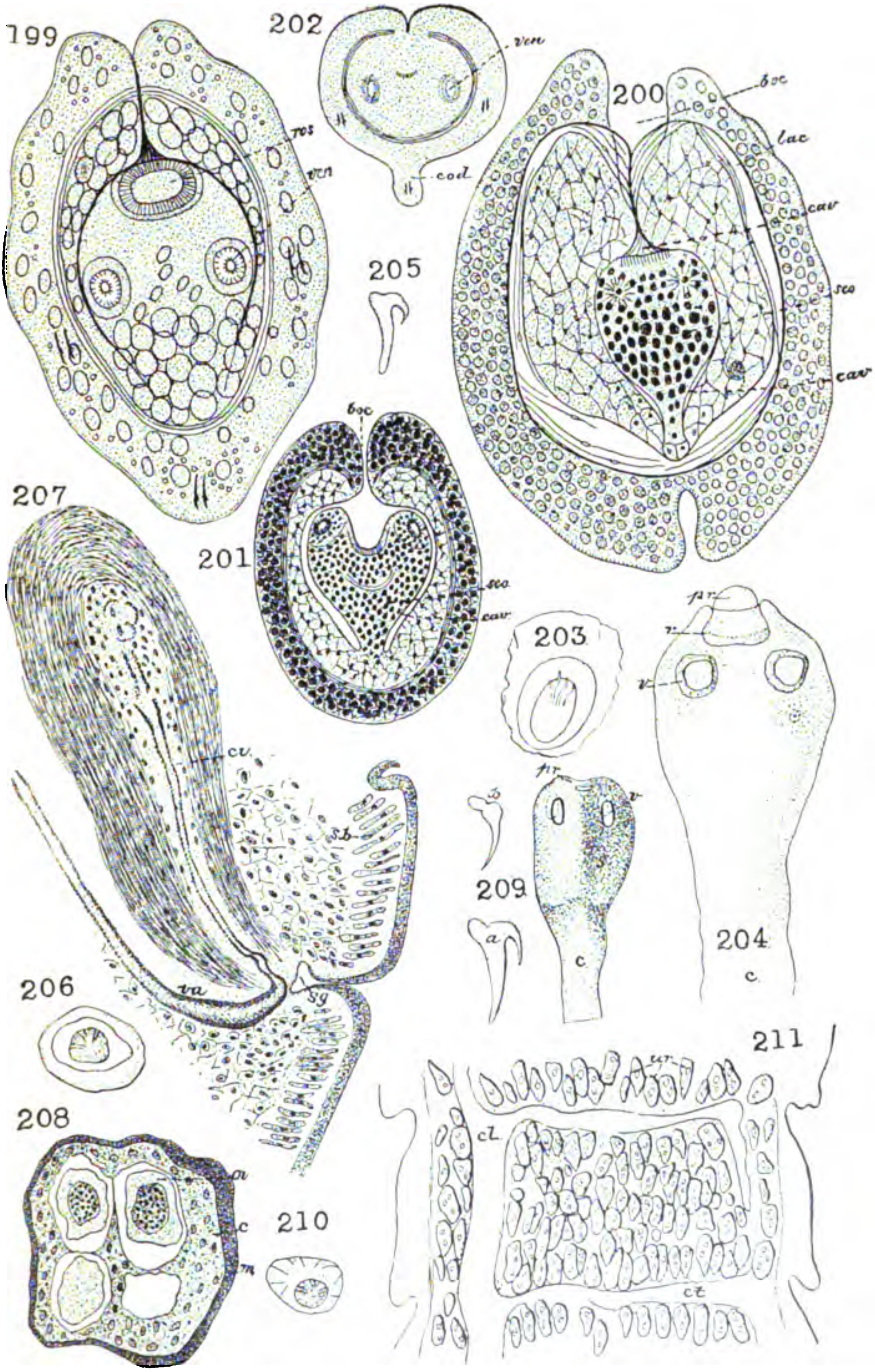
198



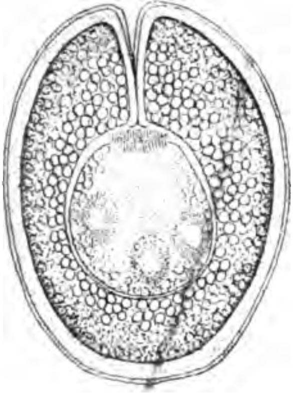
195

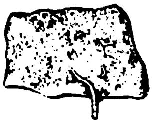


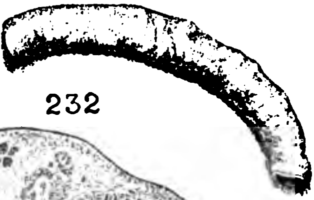
187–193. *Drepanidotænia infundibuliformis.* 194–198. *Davainea proglottina.*

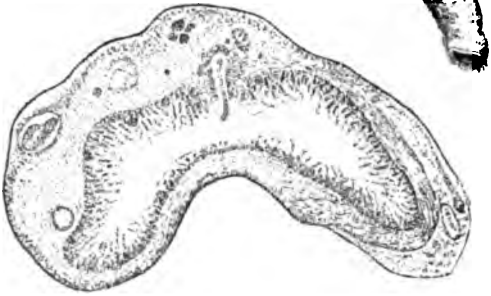


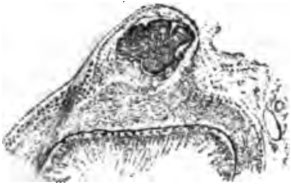
199–202. *Davainea proglottina.* **203–211.** *Davainea circumvallata.*

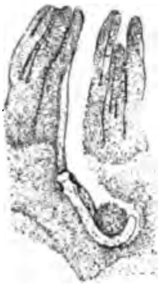
228


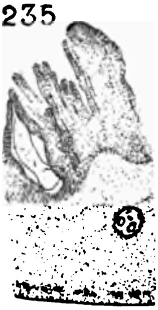
231


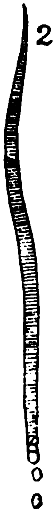
230


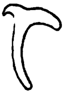
232


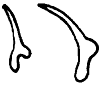
233


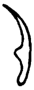
234


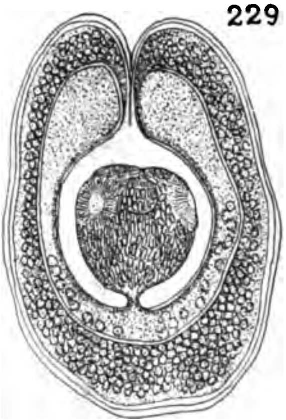
235


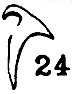
239


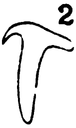
236


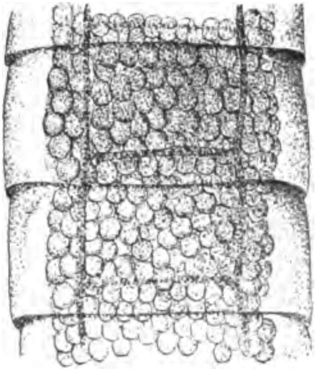
237


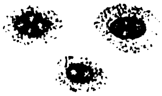
238


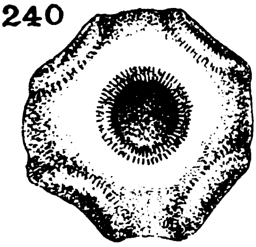
229


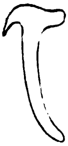
241


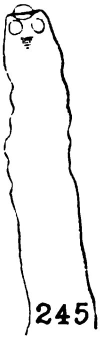
244


242


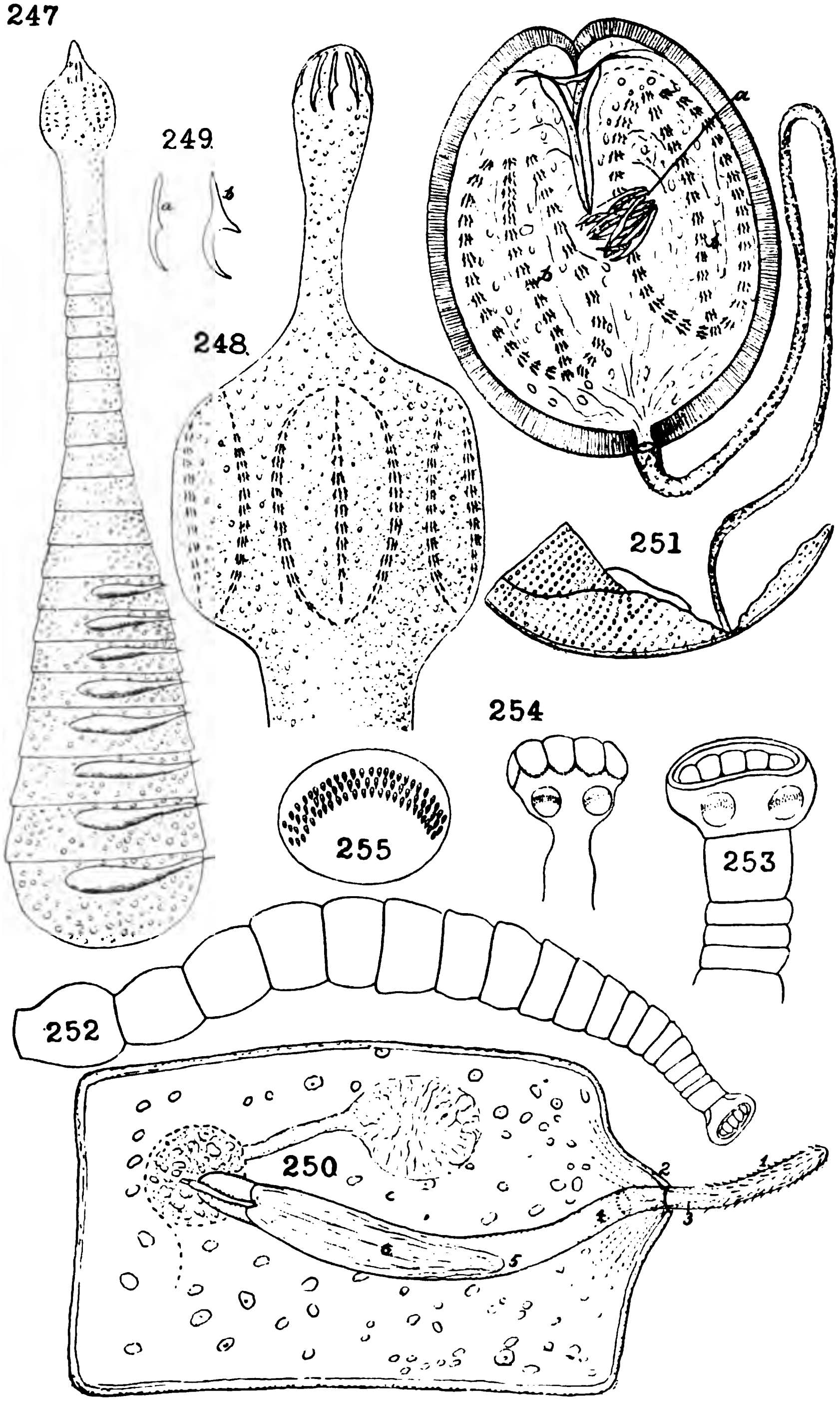
243


240


246


245


228-235. *Davainea tetragona.* 236-242. *Davainea Friedbergeri.* 243-246. *Davainea crassula*



247

249

248

251

254

253

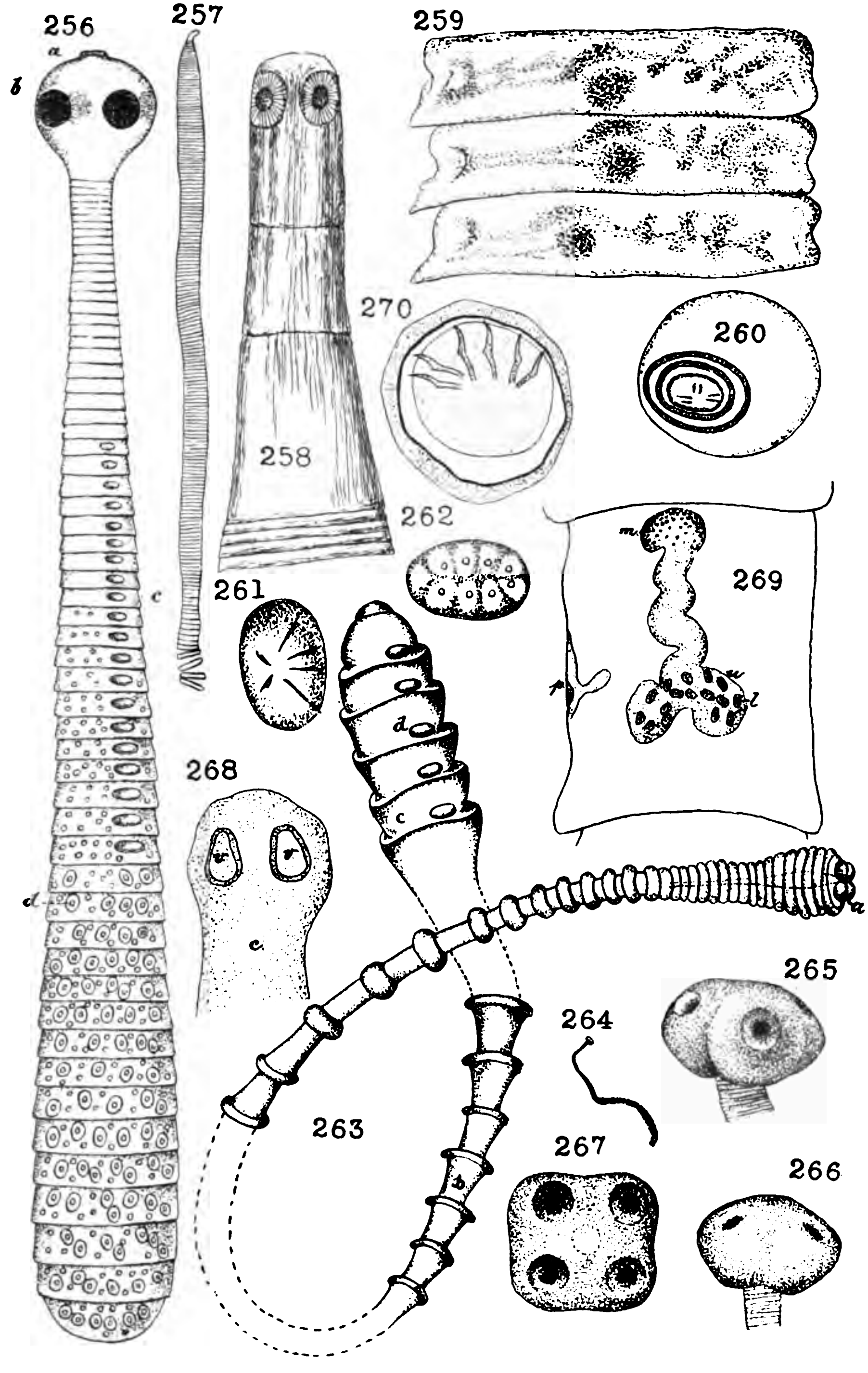
255

252

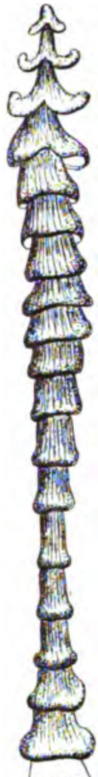
250

247-251. *Echinocotyle Rosseteri.* 252-255. *Ophryocotyle proteus.*

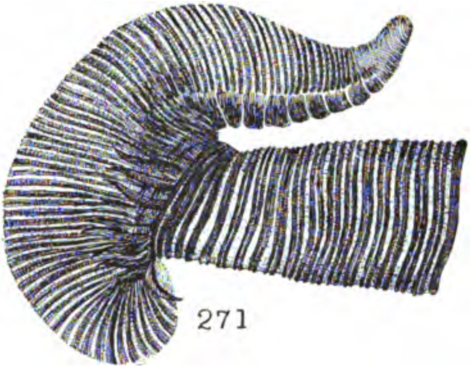
PLATE XX.



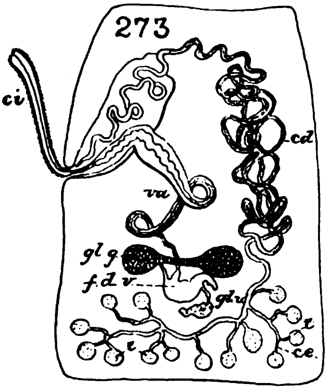
256. *Tænia cantaniana.* **257-262.** *Tænia Delafondi.* **263.** *Tænia imbutiformis.*
264-267. *Tænia megalops.* **268-270.** *Tænia nigropunctata.*



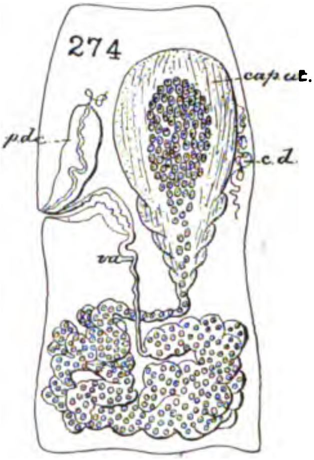
272



271

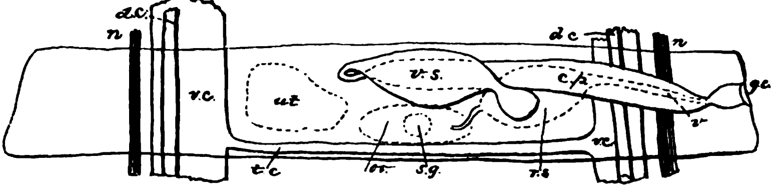


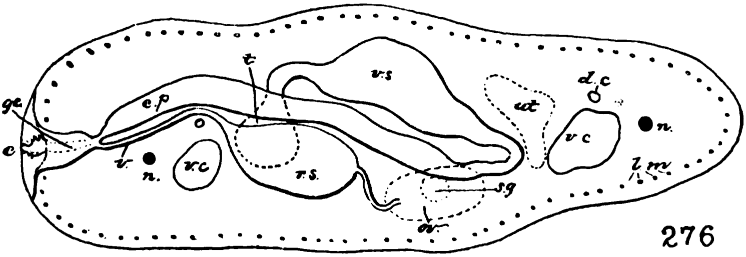
273



274

275





276

271. *Fimbriaria malleus.* 272-274. *Idiogenes otidis.* 275-276. *Tænia* sp. of Conard.

INDEX TO SCIENTIFIC NAMES.

[Parasites are given in italics; hosts are given in roman. Heavy-faced figures (**24**, **31**, etc.) refer to the more important references; c refers to chart of parasites at end of text.]

Page.

Aix sponsa c
Allobophora fœtida 10, 12, 35
Alyselminthus
    columbæ 53, 54
    crenatus 37
    infundibuliformis 43
    setigerus 41
    sinuosus 40, 41
Amabilia 23, **24**, 29, **31**, c
    lamelligera **31**, c
Anas
    acuta (see Dafila acuta) 41
    boschas 33, 34, 38, 39, 40, 44, 53, 55, c
    boschas domestica. 33, 37, 38, 39, 40, 44, 55, 59, c
    boschas fera (see Anas boschas) 35
    braziliensis 40, 59, c
    circia (see Anas querquedula) 34
    crecca 59, c
    cygnoides (see Cygnopsis cygnoides).
    fera (see Anas boschas).
    fuligula (see Aythya fuligula).
    fusca 41
    glacialis (see Clangula hyemalis).
    leucocephala (see Erismatura leucocephala).
    leucophthalma (see Aythya leucophthalma).
    leucophthalmos (see Aythya leucophthalma).
    obscura 37, c
    olor (see Olor cygnus) 34
    penelope 34, 38, c
    querquedula c
    strepera c
    superciliosa c
Anatidæ c
Anoplocephala 28
Anoplocephalinæ 24, 28
Anser
    albifrons 38, 42, c
    anser 38, 40, 58, c
        domesticus 37, 38, 40, 42, 43, 58, c
    cinereus (see Anser anser).
        domesticus (see Anser anser domesticus).
    fabalis 42, c
    segetum (see Anser fabalis).
Anseres c
Arctonetta Fischeri c
Ardea gazetta 54

Aythya Page.
    americana c
    australis 30, 31, c
    cristata (see Aythya fuligula) 40, 59
    ferina 29, 34, 37, c
    fuligula c
    marila 34, 43, 59, c
    nyroca 29, 30, 37, 59, c
    rufina 37, c
Bernicla leucopsis (see Branta leucopsis).
Biziura lobata c
Bonasa umbellus c
Bothriocephalidæ 10, **23**, **25**, 28, c
Bothriocephalinæ **23**, **25**
Bothriocephalus **24**, **25**
    claviceps 26
    cordatus 25
    cristatus 25
    dendriticus 26, c
    ditremus 26, c
    fissiceps 26
    latus 25
    liguloides 25
    longicollis 26
    Mansoni 25
    podicepes 26
    sp 10, 26
Bothriotænia 23, **24**, **26**
    longicollis 10, 25, **26**, c
Branta
    canadensis c
    leucopsis 42, c
Caccabis
    petrosa c
    saxatilis 54, c
Cairina moschata 37, c
Calidris arenaria 56
Callipepla squamata c
Camptolaimus labradorius c
Candona 12
    candida 10, 12, 33
    rostrata 10, 12, 38, 39
Carpophaga oceanica 54, c
Centrocercus urophasianus 54, c
Cercocystis Drepanidotæniæ fasciatæ 36
    gracilis 38
    setigeræ 42
    sinuosæ 40
    tenuirostris 43
Chapmania 45, 46
Charadrius hiaticula 56

Page.

- Charitonetta albeola, c
- Chenopis atrata, c
- Chen hyperborea, c
- *Choanotænia*, 61
  - *infundibuliformis*, 61
- Clangula hyemalis, c
- *Cœnurus*, 24
- Colinus virginianus, c
- Columba
  - arquatrix, c
  - fasciata, c
  - livia, 53, c
    - domestica, 44, 45, 53, 57, c
  - talpacota (see Columbigallina talpacoti).
- Columbigallina
  - passerina terrestris, c
  - talpacoti, c
- Conurus carolinensis, c
- Copepoda, 12
- Corvus
  - cornix, 32
  - corone, 32
  - frugilegus, 32
  - monedula, 32
- *Cotugnia*, 23, 24, 28, **29**, 30
  - *bifaria*, **30**, 31, c
  - *digonopora*, 10, 29, **30**, c
- Coturnix
  - communis (see Coturnix coturnix).
  - coturnix, 44, 48, 59, c
  - dactylisonans, 48, c
- *Cryptocystis*, 32
- Cyclops, 12
  - agilis, 10, 12, 13, 38, 40, 41, 43
  - brevicaudatus, 10, 12, 42
  - lucidulus, 10, 13, 40, 41
  - pulchellus, 10, 13, 43
  - sp, 12
  - viridis, 10, 13, 38, 39, 40, 41
- Cygnopis
  - canadensis (see Branta canadensis).
  - cygnoides, c
- Cygnus
  - atratus (see Chenopis atrata).
  - ferus, 40
  - gibbus, c
  - musicus (see Olor cygnus).
  - olor (see Olor cygnus).
  - olor domesticus (see Olor cygnus domesticus).
- Cypria ophthalmica, 10, 12, 33, 38, 39, 40
- Cypridæ, 55
- Cyprinidæ, 27
- Cypris, 12
  - cinerea, 10, 12, 33, 55
  - compressa, 10, 12, 33, 38, 39, 40
  - incongruens, 10, 12, 39, 40
  - ovata, 10, 12, 39, 40
  - ovum, 10, 12, 33
- Cyrtonyx montezumæ, c
- *Cysticæ*, 28
- *Cysticercus*, 24
  - *bovis*, 28
  - *tenuicollis*, 28
- *Cystoideæ*, 28
- *Cystoidotæniæ*, 28, 61
- *Cystotæniæ*, 28
- Dafila acuta, 34, 39, 40, 41, 59, c
- Daphnia, 12
- *Davainea*, 23, **25**, 27, 28, **45**, 57, 60
  - *australis*, 54, c
  - *calva*, c
  - *cesticillus*, 10, 44, **46**, 48, c
  - *circumcincta*, 54
  - *circumvallata*, **46**, **47**, 48, c
  - *columbæ*, 53
  - *contorta*, 55
  - *crassula*, 10, **46**, **53**, c
  - *echinobothrida*, 10, **46**, **49**, 50, c
  - *Friedbergeri*, **46**, **52**, c
  - *frontina*, 54
  - *insignis*, 54, c
  - *leptosoma*, 54, c
  - *madagascariensis*, 55
  - *proglottina*, 10, 11, 12, 17, **46**, **47**, 57, c
  - *retractilis*, 55
  - *Salmoni*, 55
  - *struthionis*, 10, 54, c
  - *tetragona*, 10, 12, **15**, **46**, **49**, 50, c
  - *urogalli*, 54, c
- Dendragapus obscurus, c
- Dendrocygna fulva, c
- *Dibothrium*, 25
  - *ligula*, 27
  - *longicolle*, 27
- *Dibothrius*, 25
- *Dicranotænia*, 23, **24**, 28, 32
  - *æquabilis*, 10, 32, 33, c
  - *coronula*, 10, 12, **32**, **33**, 55, c
  - *cuneata*, 35, 61
  - *furcigera*, 10, **32**, **34**, c
  - *sphenoides*, 10, 12, **32**, **35**, 61, c
- *Dilepis*, 22
- *Diplacanthus*, 31, 32
- *Diplogonoporus*, 24
- *Dipylidiinæ*, **24**, 28, 29, 61
- *Dipylidium*, **24**, 28, **29**, 30, 31
  - *caninum*, 29
- *Drepanidotænia*, 23, **24**, 28, 36, 61
  - *anatina*, 10, 12, **36**, 39, c
  - *fasciata*, 10, 12, **36**, 37, 41, c
  - *gracilis*, 10, 12, **36**, **38**, c
  - *infundibuliformis*, 10, 13, **36**, **43**, 44, c
  - *lanceolata*, 10, 32, **36**, c
  - *setigera*, 10, 12, **36**, **41**, 42, c
  - *sinuosa*, 10, 32, **36**, **40**, c
  - *tenuirostris*, 10, 13, **36**, 42, 43, c
- Dromaiidæ, c
- Dromaius movæ-hollandiæ, 54, c
- *Echinococcus*, 24
- *Echinocotyle*, 22, **25**, 28, 45, **55**, 56
  - *Rosseteri*, 10, 12, **55**, 56, c
- Ectopistes migratorius, c
- Eniconetta Stelleri, c
- *Epision*, 60
  - *plicatus*, 60
- Erismatura
  - leucocephala, 59, c
  - rubida, c
- *Fimbriaria*, **25**, 60
  - *malleus*, 60
  - *mitra*, 60

Page.

- Fringilla domestica (see Passer domesticus) 44
- Fringillidæ c
- Fuligula
  - cristata (see Aythya fuligula).
  - ferina (see Aythya ferina).
  - marila (see Aythya marila) 34
  - nyroca (see Aythya nyroca).
  - rufina (see Aythya rufina).
- Gallinæ c
- Gallus
  - domesticus 15, 27, 35, 44, 47, c
  - gallinaceus (see Gallus domesticus).
- Gammarus 12
  - pulex 10, 13, 40, 41, 43
- Garrulus glandarius 32
- Genetta genetta 28
- Geotrygon martinica c
- Glaucion clangula (see Glaucionetta clangula).
- Glaucionetta clangula 33, c
- *Globus stercoreus* 43
- Goura sp 44, c
- Gouridæ c
- Hæmatopus ostrealegus 56
- *Halysis*
  - *columbæ* 53, 54
  - *crenata* 37
  - *gracilis* 38
  - *infundibuliformis* 43
  - *lanceolata* 36
  - *setigera* 41
  - *sinuosa* 40
  - *torquata* 40
  - *trilineata* 34
- Harelda
  - glacialis (see Clangula hyemalis).
  - histrionica (see Histrionicus histrionicus).
- Helix 12, 13
  - carthusianella 10, 50, 51
  - maculosa 10, 50, 51
- Histrionicus histrionicus c
- *Hymenolepis* 24, 31, 32
  - *angulata* 32
  - *diminuta* 32
  - *farciminalis* 32
  - *murina* 32
  - *nana* 32
  - *nasuta* 32
  - *serpentulus* 32
- *Hymenolepis* (*Dilepis*) *lanceolata* 36
- *Hymenolepis* (*Lepidotrias*) *sinuosa* 40
- *Idiogenes* 25, 60
  - *otidis* 60
- *Krabbea* 24
  - *grandis* 25
- Lagopus
  - lagopus c
  - scoticus c
- Laridæ c
- Larus
  - canus 56
  - tridactylus (see Rissa tridactyla).
- *Lepidotrias* 32
- Leptotila fulviventris brachyptera c

Page.

- Lepus
  - arizonæ 55
  - melanotis 55
  - sylvaticus 55
- *Ligulinæ* 23, 27
- *Ligula* 23, 25, 27
  - *alternans* 27
  - *digramma* 27
  - *monogramma* 27
  - *sp* 10
  - *uniserialis* 27
- Limax 12, 13
  - agrestris 10, 47
  - cinereus 47
  - variegatus 10, 47
- Limosa rufa 56
- Longipennes c
- Lophodytes cucullatus c
- *Malacolepidota* 28
- Manis pentadactyla 55
- Mareca penelope (see Anas penelope) 34
- Megaloperdix Nigelli (see Tetraogallus himalayanus).
- Meleagris
  - gallopavo 57, c
  - gallopavo mexicana 45, c
- Melopelia leucoptera c
- Merganser
  - merganser 38, 43, c
  - serrator 38, 43, c
- Mergus
  - albellus 43, c
  - merganser (see Merganser merganser).
  - serrator (see Merganser serrator).
- *Mesocestoides* 23, 24, 28, 56
  - *ambiguus* 28
  - *imbutiformis* 58
  - *lineatus* 28
- *Mesocestoidinæ* 24, 28
- *Microtænia* 28
- *Monocercomonas Davaineæ tetragonæ* 50
- Musca domestica 10, 44
- Netta rufina c
- Nomonyx dominicus c
- Nucifraga caryocatactes c
- Numida ptilorhyncha c
- Nyroca
  - australis (see Aythya australis).
  - leucophthalma (see Aythya nyroca).
- Odontoglossæ c
- *Oesophagostoma columbianum* 16
- Oidemia
  - Deglandi c
  - fusca 43, c
  - nigra c
- Olor
  - cygnus 34, 42, c
    - domesticus 34, 42, c
- *Ophryocotyle* 23, 25, 45, 56
  - *insignis* 56
  - *Lacazii* 56
  - *proteus* 56
- Oreortyx pictus c
- Oriolus galbula 32, 54
- Ortalis veluta maccali c
- Ortyx virginianus (see Colinus virginianus).
- Ostracoda 12

Page.
Otis tarda 44
Parus
  major 32
  caudatus 32
  cœruleus 32
  cristatus 32
  palustris 32
Passeres c
Passer domesticus c
Pavo cristatus c
Pediocætes phasianellus c
Perca fluviatilis 39
Perdix
  cinerea (see Perdix perdix).
  coturnix (see Coturnix coturnix).
  græca (see Caccabis saxatilis).
  perdix c
  petrosa (see Caccabis petrosa).
  saxatilis (see Caccabis saxatilis).
Phasianidæ c
Phasianus
  colchicus .... 44, 52, 57, c
  gallus (see Gallus domesticus).
Philacte canagica c
Phœnicopterus
  antiquorum .... 29, 31, 37, c
  erythræus 31
  ignipaliatus 31
  minor 31
  roseus 31
  ruber .... 31, c
Pica caudata 32
Picus
  aurulentus 32
  viridis 54
Psittaci c
Psittacidæ c
Psittacus erithacus .... 53, 54, c
Pterocles alchata c
Ptychobothrium 24, 26
  claviceps 25
Ptychophysa 28
Pulex
  irritans 29
  serraticeps 29
Recurvirostra avocetta 29
Rhea
  americana (see Rhea rhea).
  rhea c
Rheidæ c
Rhynchaspis clypeata (see Spatula clypeata).
Rissa tridactyla .... 43, c
Scardafella inca c
Schistocephalus 27
  dimorphus c
Sclerolepidota 8
Somateria
  Dresseri c
  molissima borealis .... 43, c
  spectabilis c
Spatula
  clypeata c
  rhynchotis c
Staphylocystis 32
Starnœnas cyanocephala c

Page.
Stictœnas arquatrix (see Columba arquatrix).
Struthio
  australis c
  camelus c
Struthiones c
Struthionidæ c
Sturnus vulgaris 32
Tadorna vulpanser (see Tadorna tadorna) .. 38
  tadorna c
Tænia 23, 26, 28, 56, 61
  acutissima 36
  æquabilis 33
  agama .... 44, 52, 53, c
  anatina 39, 40
  anatis β lineata 34
    marila 59
    tadornæ 32
  angulata 32
  anseris 36
  anserum 36
  argentina 46
  articulis convideis 43
  australis 51, 54
  avium 43
  Bairdi c
  bifaria 29, 30
  bonasiæ c
  bothrioplites 16, 49
  bothrioplitis 49, 50, 51, 52
  breviarticulata 40, 41
  cantaniana .... 10, 46, 57, c
  Caroli c
  cesticillus 48, 49
    phasianorum 49, 52, 53
  circumcincta 54
  circumvallata 47
  clavulus 46
  collari nigro 40
  collaris 40
  collo longissimo 38
  conica .... 10, 34, 35, c
  conoidea 43
  coronula 33, 55
  crassula 53
  crateriformis 32, 54
  crenata 38
  Creplini c
  cuneata 35, 43
  cylindrica c
  Delafondi .... 10, 57, c
  digonopora 29, 30
  diminuta 32
  echinobothrida 49, 50, 51, 52
  exilis .... 10, 58, c
  fallax c
  fasciata 37, 38
  filiformis c
  flavescens 32
  flavopunctata 32
  fragilis c
  Friedbergeri 49, 52
  frontina 54
  furcigera 34
  gracilis 38, 39
    tadornæ 38

Page.

- *Tænia grœnlandica* c
  - *imbutiformis* 10, 28, 58, c
  - *infundibuliformis* 43, 44, 45, 48, 49, 61
    - *anserum* 40
    - *phasianorum* 49, 52, 53
  - *infundibulum* 43
  - *insignis* 54
  - *Krabbei* 42
  - *lævis* 29, 40, c
  - *lamelligera* 29, 31
  - *lanceolata* 36, 37, 42, 55, 56
  - *larina* 54
  - *leptosoma* 54
  - *liguloides* c
  - *linea* c
  - *lineata* 34, 35, c
  - *Linstowi* c
  - *liaphallos* c
  - *longirostris* 34
  - *malleus* 10, 60, c
  - *macracanthos* c
  - *marginata* 28
  - *megalops* 10, 35, 58
  - *micracantha* c
  - *micranoristota* c
  - *microps* 54
  - *microscopica* c
  - *microstoma* 32
  - *moschata* c
  - *multistriata* c
  - *nana* 32
  - *nasuta* 32
  - *nigropunctata* 45, 59, c
  - *obvelata* c
  - *octacantha* c
  - *odiosa* c
  - *pachycephala* c
  - *parviceps* c
  - *pediformis* c
  - *pigmentata* 47, 48
  - *polymorpha* 29
  - *porosa* 32, 40, c
  - *proglottidina* 47
  - *proglottina* 47
  - *purpurata* 32
  - *rhomboidea* 34, 35, 40
  - *saginata* 28
  - *scalaris* 32
  - *scutigera* 32
  - *serpentiformis i T. turturis* 53
  - *serpentulus* 32
  - *serrata* 43
  - *setigera* 37, 41, 42
  - *sinuosa* 32, 37, 40, 41, 42
  - *solium* 23

Page.

- *Tænia sp. conard MS* 10, 59, c
  - *sp* 10, 59, c
  - *sphenocephala* 53, 54, 57
  - *sphenoides* 35
  - *struthio cameli* 54
  - *struthionis* 54
  - *tauricollis* 46, c
  - *tenuirostris* 43
  - *tenerrina* c
  - *teres* c
  - *tetragona* 49, 50, 51, 52
  - *tiara* 32
  - *torquata* 40
  - *transverse-elliptica* c
  - *trichosoma* c
  - *trilineata* 10, 34, 35, c
  - *tubercolata* 31
  - *tuberculata* 30, 31
  - *tumens* 54
  - *turturis* 54
  - *undulata* 32
  - *villosa* c
- *Tæniidæ* 28, 28, c
- *Tæniinæ* 24, 28
- *Tetrabothriidæ* c
- *Tetrabothrium*
  - *cylindraceum* c
  - *macrocephalum* c
- Tetrao
  - bonasia (see Tetrastes bonasia).
  - tetrix 54, c
  - urogallus 54, c
- Tetraogallus himalayanus 54, c
- Tetraonidæ c
- Tetrastes bonasia c
- Tinca vulgaris 27
- Trichodectes canis 29
- Tringa alpina 56
- Turdus
  - atrigularis 32
  - iliacus 32
  - merula 32
  - musicus 32
  - pilaris 32
  - saxatilis 32
  - torquatus 32
  - viscivorus 32
- Turtur
  - auritus (see Turtur turtur).
  - turtur 53, c
- Tympanuchus americanus c
- Viverra genetta 28
- Zenaida zenaida c
- Zenaidura macroura c

BIBLIOGRAPHY OF THE TAPEWORMS OF POULTRY.

By Albert Hassall.

[Papers the dates of which are inclosed in parentheses are not accessible to me. All other references have been verified.]

Airloing.

1875.—Note sur la place d'un ténia de la poule (*Phasianus gallus*), incomplètement étudié par Dujardin. <Recueil de Méd. Vét., 6e sér., T. II, pp. 427–431.

Baird, W.

1853.—Catalogue of the species of Entozoa, or Intestinal Worms, contained in the Collection of the British Museum. London. 132 pgs. Tab. I–II.

Bätsch, A. J. G. C.

(1786.)—Naturgeschichte der Bandwurmgattung überhaupt und ihrer Arten insbesondere, nach den neuern Beobachtungen in einem systematischen Auszuge. Halle. 298 pgs., Tabs. I–V.

Bellingham, O'Bryen.

1844.—Catalogue of Irish Entozoa, with observations. <The Ann. and Mag. of Nat. Hist., Vol. XIII, pp. 101–105, 167–174, 254–260, 335–340, 422–430; Vol. XIV, pp. 162–165, 251–256, 317–323, 396–403, 471–479. London.

Bertkau.

1875.—See Cornelius, 1875.

Blanchard, Raphaël.

1891A.—Note sur les migrations du *Tænia gracilis* Kr. <Bull. Soc. zool. France, XVI, pp. 119–122, 1 fig. Reprinted. <C. R. Soc. Biol., Paris, 9e sér., III, séance du 9 mai (pub. 15 mai), pp. 330–332.

1891B.—Notices helminthologiques (2 sér.): 6.—Sur les Téniadés a ventouses armées. <Mém. Soc. zool. France, IV, pp. 420–443, figs. 1–20.

1891C.—Histoire zoologique et médicale des Téniadés du genre *Hymenolepis* Weinland. Paris. 112 pgs., 22 figs.

1894.—Notices sur les parasites de l'homme (3e série): IV.—Sur le *Krabbea grandis*, et remarques sur la classification des Bothriocéphalinés. <C. R. Soc. Biol., 10e sér., I, No. 27, séance du 3 nov. (pub. 9 nov.), pp. 699–702.

Bloch, M. E.

(1779.)—Beitrag zur Naturgeschichte der Würmer, welche in anderen Thieren leben. <Beschäft. d. Berl. Ges. nat. Frde., IV, pp. 534–561, Taf. XII, figs. 3–5, Taf. XIV–XV.

1782.—Abhandlung von der Erzeugung der Eingeweidewürmer und den Mitteln wider dieselben. Berlin. 4°. 54 pgs., 10 pls.

Clouet, J.

(1872.)—Note sur le Tænia crassule du pigeon, sur la gapes, maladie des jeunes poulets. <Soc. des Amis Sci. nat., Rouen, 6e et 7e ann. (1870–1871), pp. 49–53.

Cobbold.

1859.—On some new forms of Entozoa. <Trans. Linnean Soc. London, XXII (1856–1859), pp. 363–366, Tab. LXIII.

1861.—List of Entozoa, including Pentastomes, from animals dying at the society's menagerie, between the years 1857–60 inclusive, with descriptions of several new species. <Proc. Zool. Soc. London, pp. 117–127, Pl. XX.

CORNELIUS.

1875.—Taubenbandwurm. <(Sitz. d. niederrheinischen Gesellschaft für Natur- und Heilkunde in Bonn) Verh. d. natur-hist. Vereins d. pr. Rheinland u. Westfalens, XXXII, iv, 2, pp. 182–183.

CREPLIN.

1825.—Observationes de Entozois. P. I. Gryphisw. 8°. 86 pgs., 1 Taf.,

(1839.)—Eingeweidewürmer. <Ersch und Grube's Encycl., XXXII, pp. 277–302. Leipzig.

1846.—Nachträge zu Gurlt's Verzeichniss der Thiere, bei welchen Entozoen gefunden worden sind. <Arch. f. Naturg., 12. Jhg., 1. Bd., Berlin, pp. 129–160.

CRETY, C.

1890.—Cestodi della *Coturnix communis* Bonn. <Boll. Mus. Zool. ed Anat. Comp. Univ. Torino, Vol. V, N. 88, pp. 1–16, 1 tav. (Actual date of publication, Oct. 7, 1890.)

DAVAINE, C.

1877.—Traité des Entozoaires et des maladies vermineuses de l'homme et des animaux domestiques. Paris. 2ᵉ éd., CXXXII pgs., 72 figs.; 1003 pgs., 38 figs.

DIAMARE, V.

1893A.—Note su' Cestodi. <Boll. Soc. Nat. Napoli, Ser. 1, Vol. 7, Fasc. I—II, pp. 9–13. (Actual date of publication, Aug. 28, 1893.)

1893B.—Le funzioni dell' ovario nella *Davainea tetragona* Mol. <Rend. R. Accad. sci. fis. e matem. Napoli, fasc. 8–12. Adun., 9 Dec., 4°, 7 pgs. (reprint), 4 figs.

DIESING, C. M.

1850.—Systema helminthum. I. Vindobonæ. 680 pgs.

1863.—Revision der Cephalocotyleen: Abth. Paramecocotyleen. <Sitzbr. k. Akad. Wiss. Wien, Math., nat. Cl., Bd. 48, 1. Abth., pp. 200–345.

1864.—Revision der Cephalocotyleen: Abth. Cyclocolyteen. <Sitzbr. k. Akad. Wien, XLIX, 1. Abth., pp. 357–430.

DONNADIEU, A. L.

1877.—Contribution à l'histoire de la Ligule. <Journ. de l'Anat. et de la Phys., XIII, pp. 324–370, 451–497, Pl. XIV–XX. (Contains historical review and bibliography.)

DUCHAMP, G.

(1876.)—Recherches anatomiques et physiologiques sur les Ligules. <Propos, donn. p. la Faculté Lyon, Paris, 64 pgs., 2 Pls. Abstr. <Journ. d. Zool., T. V, pp. 372–373.

1877.—Sur les conditions de développement des Ligules. <C. R. Ac. Sci. Paris, T. 85, pp. 1239–1240.

1878A.—Sur les conditions de développement des Ligules. Deuxième note. <C. R. Ac. Sc. Paris, T. 86, pp. 493–494. Rev. <Rev. scientif. (1877–1878), No. 35, p. 833.

1878B.—Expériences sur les conditions du développement des Ligules. <Ann. Sci. Nat., 6ᵉ sér., Zool., T. VII, No. 2–4, Art. No. 7, 1 pg. —— Abstr. as: The Development of Ligula. <Ann. and Mag. Nat. Hist., Vol. II, 5th ser., p. 498. (Abstract of Duchamp, 1877 and 1878.)

DUJARDIN, FÉLIX.

1845.—Histoire naturelle des Helminthes, ou vers intestinaux. Paris. 654 pgs., Pls. I–XII.

FEUEREISEN, J.

1868.—Beitrag zur Kenntniss der Taenien. <Zeitschr. f. wiss. Zool., Bd. XVIII, Heft 2, pp. 161–205, Taf. X.

FILIPPI, C. DE.

1892.—Nota preliminare sul sistema riproduttore della *Tænia bothrioplitis* Piana. <Boll. Soc. Rom., Stud. Zool., Ann. 1, pp. 75–79, tav. 1.

FRIEDBERGER.

1877.—Bandwurmseuche unter den Fasanen. <Zeitschr. f. Vet.-Wissenschf., V, No. 3, März, pp. 97–112, figs.

FRIIS.

(1870.)—En hidtil ubeskreven Baendelorm hos Fugle (Ophryocotyle proteus). <Videnskab. Meddel. fra den Naturhist. For Kjöbenhavn (1869), pp. 121–124, 1 tav.

FRISCH, J. L.

(1727.)—De tæniis in anserum intestinis. <Miscell. Berolinensia, ad incrementum scientiarum ex scriptis Societati Regiæ Scientiarum exhibitis. Contin. II, Berolini, p. 42.

1781.—Von Bandwürmern in den Gedärmen der Gänse. <Physicalische u. medicinische Abhandlungen der k. Acad. d. Wiss. zu Berlin, I, pp. 155–156.

FRÖLICH, J. A.

1789.—Beschreibung einiger neuen Eingeweidewürmer. <Der Naturforscher, XXIV, pp. 101–162, Tab. IV.

1791.—Beiträge zur Naturgeschichte der Eingeweidewürmer. <Der Naturforscher, XXV, pp. 52–113, Tab. III.

1802.—Beiträge zur Naturgeschichte der Eingeweidewürmer. <Der Naturforscher, XXIX, pp. 5–96, Tab. I–II.

GERVAIS.

1847.—Sur quelques Entozoaires tænioïdes et hydatides. <Acad. Sci. et Lettres de Montpellier, Mém. de la Sec. d. Sci., T. I, pp. 85–103, Pl. I–II.

GIEBEL, C.

1857.—Chr. L. Nitzsch's helminthologische Untersuchungen. <Zeitschr. ges. Naturwiss., Bd. IX, pp. 264–269. Berlin.

GMELIN.

1790.—Systema naturæ. Tom. I, Pars. VI, (pp. 3021–3909). (Leipsic ed.)

GOEZE, J. A. E.

1782.—Versuch einer Naturgeschichte der Eingeweidewürmer thierischer Körper. Blankenburg, 471 pgs., 35 plates.

GRASSI, B., & ROVELLI, G.

1888.—Bandwürmerentwickelung. I. <Centralbl f. Bakt. und Parasitenk., III, p. 173.

1889A.—Embryologische Forschungen an Cestoden. <Centralbl. f. Bakt. und Parasitenk., V, pp. 370–377, figs. 1–4, pp. 401–410.

1889B.—Intorno allo sviluppo dei Cestodi. <Bull. Mensile Accad. Gioenia Sci. Nat. Catania, Fasc. VIII, pp. 4–5.

1892.—Ricerche embriologiche sui Cestodi. <Atti Accad. Gioenia Sci. Nat. Catania, Anno LXVIII (1891–1892), Ser. IV, Vol. IV, Memoria II, pp. 1–108, Tav. I–IV.

HAMANN, OTTO.

1889.—In *Gammarus pulex* lebende Cysticerkoiden mit Schwanzanhängen. <Jen. Zeitschr. f. Naturw. (1889–1890), Bd. XXIV, n. F., XVII, pp. 1–9, Taf. I. (Actual date of publication, Nov. 20, 1889.)

1891.—Neue Cysticercoiden mit Schwanzanhängen. <Jen. Zeitschr. f. Naturw. (1890–1891), Bd. XXV, n. F. XVIII, pp. 553–564, Taf. XXIV. (Actual date of publication, May 30, 1891.)

HASSALL, ALBERT.

1896A.—Check list of the Animal Parasites of Chickens. <Circular No. 9, pp. 1–7, Bureau of Animal Industry, U. S. Department of Agriculture.

1896B.—Check list of the Animal Parasites of Turkeys. <Circular No. 12, pp. 1–3. Bureau of Animal Industry, U. S. Department of Agriculture.

1896C.—Bibliography of the tapeworms of Poultry. <Bulletin No. 12, Bureau of Animal Industry, U. S. Department of Agriculture, Washington, D. C. pp. 81–88. The present paper.

ITZIGSOHN.

? ? Quoted by Railliet, 1893, p. 329.

JANSON.

1893.—Die Hausthiere in Japan. IV. Die Krankheiten der Hausthiere in Japan. <Arch. f. wiss. u. prakt. Thierheilkunde, XIX, pp. 241–276.

KOWALEWSKY, M.

1894A.—Materyaly do fauny helmintologicznej pasorzytniczej polskiej, 1. <? pp. 1–8.

1894B.—Fauna helmintologiczna pasorzytnicza Krajowa naszych zwierząt i róslin uzytecznych oraz czlowieka. <Rocznika Krajowei, etc., pp. 214–227.

1894C.—Studya helmintologiczne, 1. (Helminthologische Studien, 1.) <Anz. der Akademie der Wissenschaften in Krakau, November, pp. 278–280, 1 Taf.

1895.—Studya Helmintologiczne, 1. <Rozpraw Wydzialu matematyczno-przyrodniczego Akademii Umiejetnosci w Krakowie, Tom XXIX, pp. 349–367, T. VIII.

KRABBE, H.

1867.—Trappens Bændelorm. <Videnskabelige Meddelelser fra den naturhistoriske Forening i Kjöbenhavn, for Aaret 1867, Nr. 4–7, pp. 122–126, Tab. III.

1869.—Bidrag til Kundskab om Fuglenes Bændelorme. <Kgl. Dansk Vidensk. Selsk. Skrifter, 5. R., Naturvid. og math. Afd. 8. Bd. VI, 1870, pp. 251–363; Résumé: Recherches sur les Ténias des oiseaux, pp. 364–368, Taf. I–IX. (Author's extras published 1869.)

1882.—Nye Bidrag til Kundskab om Fuglenes Bændelorme. <Vidensk. Selsk. Skrifter, 6. Række, Naturvid. og math. Afd. I. 7, pp. 345–366, Tab. I–II.

KREFFT, G.

(1871.)—On Australian Entozoa, including a list of the species hitherto recorded, and descriptions of 16 new tapeworm colonies, with figures of each drawn from fresh specimens. <Trans. Ent. Soc. New South Wales, pp. 206–232, 3 plates. Also separate, 28 pages, 3 plates. 8°.

LINSTOW, O. VON

1872A.—Ueber den *Cysticercus tæniæ gracilis*, eine freie Cestoden-amme des Barsches. <Arch. f. mikr. Anat., VIII, pp. 535–537, Pl. XXI, figs. 1–5.

1872B.—Sechs neue Taenien. <Arch. f. Naturges., 38. Jhg., I, pp. 55–58, Taf. III.

1878.—Compendium der Helminthologie. Hannover. (Actual date of publication, May 16, 1878.)

1889.—Compendium der Helminthologie. Nachtrag. Hannover.

1892A.—Beobachtungen an Helminthenlarven. <Arch. f. mikr. Anat., XXXIX, pp. 325–343, Taf. XV.

1892B.—Beobachtungen an Vogeltaenien. <Centralbl. f. Bakter. u. Parasitenk., XII, 7 Oct., pp. 501–504, figs. 1–3.

1893.—Helminthologische Studien. <Jenaische Zeitschrift für Naturwissenschaft, XXVIII Bd., n. F., XXI, pp. 328–342, Taf. XXII–XXIII.

LÖNNBERG, EINAR.

1889.—Bidrag till Kännedomen om i Sverige förekommande Cestoder. <Bihang till k. Svenska Vet-Akad. Handlingar, Bd. 14, Afd. IV, No. 9, pp. 1–69, Taf. I–II.

1890.—Helminthologische Beobachtungen von der Westküste Norwegens. <Bihang till k. Svenska Vet.-Akad. Handlingar, Bd. 16, Afd. IV, No. 5, pp. 1–47.

LÜPKE, F.

1892.—Parasitologisches. *Tænia crassula* in einem Papagei. <Repert. d. Thierheilkunde, Jhg. 53, pp. 257–264.

Magalhães.

1892.—Notes d'helminthologie brésilienne. I.—*Tænia cuneata* von Linstow, 1872. <Bull. Soc. zool. France, XVII, pp. 145–146.

Mégnin, P.

1878A.—Épizooties vermineuses chez les jeunes faisans. <(Bull. Soc. cent. méd. vét.) Recueil de méd. vét., 6e sér., V, pp. 825–829. Discussion, pp. 830–831. Pub. 30 août.

1878B.—Supplement (to 1878A). <Rec. méd. vét., 6e sér., V, pp. 927–928, Pl. IV. Pub. 30 Sept.

1880A.—De la caducité des crochets et du scolex lui-même chez les Ténias. <Bull. Soc. zool. France, V (3–4), pp. 117–120.

1880B.—De la caducité des crochets et du scolex lui-même chez les Ténias. <Recueil de méd. vét., VII, 6e sér., pp. 393–396. Discussion, pp. 393–394.

1880C.—Sur la caducité des crochets et du scolex lui-même chez les Ténias. <C. R. Acad. Sci. Paris, XC, pp. 715–717. (Nearly the same as 1880B, pp. 393–396, but abbreviated).

1881A.—De la caducité des crochets et du scolex lui-même chez les Ténias. <Journ. Anat. et Phys., Paris, XVII, pp. 27–44, Pl. IV–V.

1881B.—Sur la caducité des crochets et du scolex lui-même chez les Ténias. <C. R. Soc. Biol., 7e sér., T. II, pp. 124–127 (séance du 13 mars 1880). (Almost verbatim, same as 1880B, pp. 393–396.)

1891.—Un nouveau Ténia du pigeon ou plutôt une espèce douteuse de Rudolphi réhabilitée. <C. R. Soc. Biol. Paris, 9e sér., T. III, pp. 751–753, figs. a–f.

Molin, R.

1858.—Prospectus helminthum, quæ in prodromo faunæ helminthologicæ Venetiæ continentur. <Sitzber. k. Akad. Wiss. Wien, math.-naturw. Cl., Bd. XXX, pp. 127–158.

1861.—Prodromus faunæ helminthologicæ Venetæ adjectis disquisitionibus anatomicis et criticis. <Denkschr. k. Akad. Wiss. Wien, Bd. XIX, pp. 189–338, 15 Taf.

Moniez, R.

1891.—Notes sur les Helminthes. II. Sur les Cysticerques des Ostracodes d'eau douce. <Rev. Biol. Nord France, IV, pp. 25–26.

Monticelli, F. Sav.

1889.—Notes on some Entozoa in the collection of the British Museum. <Proc. Zool. Soc. London, pp. 321–325, Pl. XXXIII.

1891.—Notizie su di alcune specie di Tænia. <Boll. Soc. Nat. Napoli, Ser. I, Vol. V, Fasc. II, pp. 151–174, Tav. VIII.

Moore, V. A.

1895.—A nodular Tæniasis in fowls. <Circular No. 3, Bureau of Animal Industry, U. S. Dept. Agric., 4 pgs., figs, 1–2.—Abstr., as: A nodular disease of fowls associated with tapeworm. <N. Y. Med. Journ., Vol. LXII, No. 12, pp. 373–374.—Abstr. < pp. 15–17 Bull. 12. Bureau of Animal Industry. 1896.

Mrázek, Al.

1890.—Ueber Cysticercoiden unserer Crustaceen. <Sitzber. k. böhm. Ges. Wiss., math.-nat. Cl., Jhg. 1890, Bd. I, pp. 226–248, Taf. V, figs. 1–14; VI, figs. 15–17. (Text Bohemian.)

1891.—Beiträge zur Entwickelungsgeschichte einiger Vogelbandwürmer. <Sitzber. k. böhm. Ges. Wis., math.-nat. Cl., Jhg. 1891, pp. 97–131, Taf. V, figs. 1–17; VI, figs. 18–27. (Text Bohemian.) Résumé and explanation of plates in French: Recherches sur le développement de quelques Ténias, pp. 126–131.

Müller, O. F.

(1782.)—Vom Bandwurme des Stichlings und vom milchigten Plattwurme. <Der Naturforscher, XVIII, pp. 21–37, I Taf.

Neumann, L. G.

1888.—Traité des maladies parasitaires non microbiennes des animaux domestiques. 673 pgs., 306 figs. Paris.

1892A.—Traité des maladies parasitaires non microbiennes des animaux domestiques. 2e éd. 767 pgs., 364 figs. Paris.

1892B.—A Treatise of the Parasites and Parasitic Diseases of the Domesticated Animals. 800 pgs., 364 figs. London. Translation of 1892 A, by Fleming.

Owen, R.

1835.—Description of a new tapeworm, *Tænia lamelligera*, Owen. <Trans. Zool. Soc. London, I, pp. 385–386, Pl. XLI, figs. 21–23.

Pagenstecher.

(1858.)—Beitrag zur Kenntniss der Geschlechtsorgane der Taenien. <Zeitschr. f. wiss. Zool., IX, pp. 523–528, Taf. XXI.

Pallas, P. S.

(1781.)—Bemerkungen über die Bandwürmer in Menschen und Thieren. <Neue nord. Beyträge z. physik. und geogr. Erd- und Völkerbeschreibung, Naturg. u. Oeconomie, Bd. I, Petersb. u. Leipzig, pp. 39–112, 2 Taf.

Parona, C.

(1885.)—Di alcuni elminti raccolti nel Sudan orientale da O. Beccari e P. Magretti. <Ann. Mus. Civ. Genova, Ser. II, Vol. II, pp. 424–445, Tav. VI–VII.

(1887A.)—Elmintologia sarda. Contribuzione allo studio dei vermi parassiti in animali di Sardegna. <Ann. Mus. Civ. Genova, Ser. II, Vol. IV, pp. 275–384, Tav. V–VII.

(1887B.)—Res ligusticae II. Vermi parassiti in animali della Liguria. Nota preventiva. <Ann. Mus. Civ. Genova, Ser. II, Vol. IV, pp. 483–501.

1894.—L' Elmintologia italiana. Da' suoi primi tempi all' anno 1890. Storia, sistematica, corologia e bibliografia. <Atti R. Università Genova, XIII, 4°, 733 pgs., 1 map.

Pasquale, Alessandro.

1890.—Le Tenie dei polli di Massaua (descrizione di una nuova specie). <Giorn. Internaz. Sci. Med., Anno XII, Fasc. 23, 15 dicembre, pp. 905–910, 1 Tav., 11 figs.

Perroncito, E.

1882.—I parassiti dell' uomo e degli animali utili. 506 pgs., 233 figs. Milano.

1886.—Trattato teorico-pratico sulle malattie più comuni degli animali domestici. 434 pgs., 220 figs. Torino.

Piana, G. P.

1881.—Una nuova specie di Tenia della gallina (*Tænia bothrioplites*) e di un nuovo Cisticerco delle lumachelle terrestri (*Cisticercus bothrioplites*). <Rendiconto Accad. Sci. Inst. Bologna (Anno accad., 1880–1881), pp. 84–85.

1882.—Di una nuova specie di Tenia del gallo domestico (*Tænia bothrioplitis*) e di un nuovo Cisticerco delle lumachelle terrestri (*Cysticercus bothrioplitis*). <Mem. Accad. Sci. Inst. Bologna, Ser. 4, Tom. II (1880–1881), pp. 387–394, 1 double plate w. 8 figs.

Polonio, A. F.

1860A.—Novæ helminthum species. <Lotos (Prag), Feb., X, pp. 21–23.

1860B.—Catalogo dei cefalocotilei italiani, e alcune osservazioni sul loro sviluppo. <Atti Soc. Ital. Sci. Nat., II, pp. 217–229, Tav. VII, Milano (1859–1860).

Railliet, A.

1886.—Éléments de zoologie médicale et agricole. Paris. 1053 pgs., 705 figs.

1892A.—Sur un Ténia du pigeon domestique, représentant une espèce nouvelle (*Tænia Delafondi*). <C. R. Soc. Biol. Paris, 9e sér., T. IV (séance du 23 jan., pub. 29 jan.), pp. 49–53.

RAILLIET, A.—Continued.

1892B.—Notices parasitologiques. VII.—*Tænia tenuirostris* Rud. chez l'oie domestique; remarques sur la classification des Cestodes parasites des oiseaux. <Bull. Soc. Zool. France, XVII, No. 5, pp. 115–116.

1893.—Traité de zoologie médicale et agricole. I. Fasc., pp. 1–736, figs. 1–494.

1896.—Quelques rectifications à la nomenclature des parasites. <Rec. d. Méd. Vét., VIII^e. sér., Tom., III, No. 5, pp. 157–161.

—— & LUCET.

1892.—Sur le *Davainea proglottina* Davaine. <Bull. Soc. zool. France, XVII, No. 5, pp. 105–106.

RICHARD, J.

1892.—Sur la présence d'un Cysticercoïde chez un Calanide d'eau douce. <Bull. Soc. zool. France, XVII, No. 1, pp. 17–18.

RIEHM, G.

1882.—[Fütterungsversuche mit *Ligula simplicissima.*] <Zeitschr. naturw. Ver. Halle, LV, pp. 328–330.

RIVOLTA, S., e DEL PRATO, P.

(1881.)—L' ornitoiatria, o la medicina degli uccelli domestici e semi-domestici. Pisa.

ROSA, VINCENZO.

(1794.)—Lettere zoologiche, ossia osservazioni sopra diversi animali. <Giorn. Fis. Medico del Brugnatelli, Vol. IV, Ann. VII, pp. 258–269.

ROSSETER, T. B.

1890.—Cysticercooids parasitic in *Cypris cinerea.* <Journ. Micr. and Nat. Sci., III, n. s., Vol. IX, pp. 241–247, Pl. XVI–XVII.

1891A.—[Life history of *Tænia lanceolata.*] <Journ. R. Micr. Soc., June, 2 ser. 11, p. 438.

1891B.—Sur un Cysticercoïde des Ostracodes, capable de se développer dans l'intestin du canard. <Bull. Soc. zool. France, XVI, pp. 224–228.

1892.—On a new Cysticercus and a new Tapeworm. <Journal Queckett Micr. Club, Ser. II, Vol. IV, No. 30, Jan. (read Oct. 16, 1891), pp. 361–366, Pl. XXII–XXIII.

1893.—On the Cysticercus of *Tænia microsoma* and a new Cysticercus from *Cyclops agilis* (Rosseter). <Journ. Queckett Micr. Club (2), V, No. 32, July (read Nov. 18, 1892), pp. 179–182, Pl. X.

1894.—On *Cysticercus quadricurvatus* Ross. <Journ. Queckett Micr. Club (2), V, No. 34 (read Nov. 19, 1893, pub. April, 1894), pp. 338–343, Pl. XVII.

RUDOLPHI, C. A.

1793.—Observationes circa vermes intestinales. Diss. In. Fasc. I. Gryphiswald, 46 pgs.

(1795.)—Observationes, Fasc. 2.

1802.—Fortsetzung der Beobachtungen über die Eingeweidewürmer. <Arch f. Zool. u. Zoot. II, St. 2, pp. 1–67, Taf. I.

1810.—Entozoorum sive vermium intestinalium historia naturalis, Vol. II, pgs. II, 386 pgs.

1814.—Erster Nachtrag zu meiner Naturg. d. Eingeweidewürmer. <Ges. Naturf. Freunde Berlin, Mag. f. d. neust. Entd. i. d. ges. Naturkde., VI. Jhg., Berl., pp. 83–113.

1819.—Entozoorum synopsis. Berlin. 811 pgs Tab. I–III.

SCHMIDT, JOHS. EM.

1894.—Die Entwicklungsgeschichte und der anatomische Bau der *Tænia anatina* (Krabbe). <Arch. f. Naturg., Jhg. 60, Bd. I, pp. 65–112, Taf. VI. —— Also as Inaug.-Diss. Leipzig, pp. 1–50, I Taf. —— Ref. by Max Braun. <Centralbl. Bakter. und Parasitenk., XVI, pp. 756–758. ——Review as: Development of *Tænia anatina.* <Journ. R. Micr. Soc. London, P. I, p. 58.

SCHRANK, F. v. P.

(1788.)—Verzeichniss der bisher hinlänglich bekannten Eingeweidewürmer, nebst einer Abhandlung über ihre Anverwandtschaften. München.

1803.—Fauna Boica. Durchgedachte Geschichte der in Baiern einheimischen und zahmen Thiere. Landshut, 3. Bd., 2. Abth., 372 pgs. (Eingeweidewürmer, pp. 117-248.)

SCOPOLI, J. ANT.

1772.—Annus V. historico-naturalis. Lipsiæ. 128 pgs. 8°.

SCOTT, TH.

1891.—Notes on a Small Collection of Fresh-water Ostracoda from the Edinburgh District. <Proc. R. Physical Soc., Edinb., X (1890-1891), part 2, pp. 313-317, 1 fig.

SCOULAR, JOHN.

1829.—Account of the Tænia found in the Intestines of the Common Grouse (*Tetrao scoticus*). <Edinb. New Philos. Journ., XX (1828), pp. 81-83.

SIEBOLD, C. TH. v.

1837.—Zur Entwickelungsgeschichte der Helminthen. < K. F. Burdach's: Die Physiologie als Erfahrungswissenschaft, Bd. II, 2. Aufl., Leipzig, pp. 183-213.

1848.—Lehrbuch der vergleichenden Anatomie, Bd. I. (Wirbellose Thiere.)

1854.—Comparative anatomy. From the German, with notes and additions by Waldo I. Burnett, M. D. Boston. 470 pgs. (Translation of 1848.)

STEUDENER, F.

1877.—Untersuchungen über den feineren Bau der Cestoden. < Abh. Ges. Halle, XIII, pp. 277-316, Pl. XXVIII-XXXI.

STILES, CH. WARDELL.

1896.—Report upon the Present Knowledge of the Tapeworms of Poultry. <Bulletin No. 12, Bureau of Animal Industry, U. S. Department of Agriculture, Washington, D. C. pp. 1-79, Pls. I-XXI. The present paper.

STOSSICH, M.

1890A.—Elminti veneti raccolti dal Dr. Alessandro Conte de Ninni. <Boll. Soc. Adriat. Sci. Nat., Vol. XII. pp. 49-56. Trieste.

1890B.—Elminti veneti raccolti dal Dr. Alessandro Conte de Ninni. < Boll. Soc. Adriat. Sci. Nat., Trieste, XII, pp. 49-56.

1891.—Elminti veneti raccolti dal Dr. Alessandro Conte de Ninni. IIa Ser. < Boll. Soc. Adriat. Sci. Nat., Trieste, XIII, pp. 109-116, Tav. I.

1892.—Osservazioni elmintologiche. < Soc. Hist. Nat. Croatica, T. VII, Agram. 10 pgs., 2 Tav.

VILLOT.

(1875.)—Faune helminthologique de la Bretagne. < Arch. Zool. Expér., Bd. IV, p. 478, Pl. XII, f. 92.

WEINLAND, D. F.

1858.—Human Cestoides. An Essay on the Tapeworms of Man, giving a full account of their nature, organization, and embryonic development; the pathological symptoms they produce, and the remedies which have proved successful in modern practice. To which is added an appendix, containing a catalogue of all species of *helminthes* found in man. 8°. 93 pgs., 12 figs. Cambridge (Mass.). (Actual date of publication, prior to Sept. 30, 1858.)

ZEDER, J. G. H.

1800.—Erster Nachtrag zur Naturgeschichte der Eingeweidewürmer, mit Zufässen und Anmerkungen herausgegeben. Leipzig. 4° 320 pgs., VI Taf.

1803.—Anleitung zur Naturgeschichte der Eingeweidewürmer. Bamberg. 432 pgs. 8°. 4 Taf.

ZÜRN.

1882.—Die Krankheiten des Hausgeflügel. Weimar. 237 pgs., 76 figs.

BULLETIN NO. 13.

U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF ANIMAL INDUSTRY.

TUBERCULOSIS INVESTIGATIONS.

THE GROWTH OF THE TUBERCULOSIS BACILLUS UPON ACID MEDIA.

By E. A. de Schweinitz and Ma[illegible]ion Dorset.

FURTHER EXPERIMENTS WITH AN ATTENUATED TUBERCULOSIS BACILLUS.

By E. A. de Schweinitz and E. C. Schroeder.

THE EFFECT OF TUBERCULIN INJECTIONS UPON THE MILK OF HEALTHY AND DISEASED COWS.

By E. A. de Schweinitz.

Prepared under the direction of

Dr. D. E. SALMON,

Chief of the Bureau of Animal Industry.

Issued September 19, 1896.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1896.

BULLETIN NO. 13.

U. S. DEPARTMENT OF AGRICULTURE.
BUREAU OF ANIMAL INDUSTRY.

TUBERCULOSIS INVESTIGATIONS.

THE GROWTH OF THE TUBERCULOSIS BACILLUS UPON ACID MEDIA.
By E. A. DE SCHWEINITZ and MARION DORSET.
FURTHER EXPERIMENTS WITH AN ATTENUATED TUBERCULOSIS BACILLUS.
By E. A. DE SCHWEINITZ and E. C. SCHROEDER.
THE EFFECT OF TUBERCULIN INJECTIONS UPON THE MILK OF HEALTHY AND DISEASED COWS.
By E. A. DE SCHWEINITZ.

Prepared under the direction of
DR. D. E. SALMON,
Chief of the Bureau of Animal Industry.

Issued September 19, 1896.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1896.

M10U

LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY,
Washington, D. C., July 15, 1896.

SIR: I have the honor to transmit herewith, and to recommend for publication as a bulletin of this Bureau, the manuscript containing a report of investigations upon the cultivation of the tuberculosis bacillus upon acid media, and of some further experiments with reference to the effect of tuberculin upon the milk of cows.

These experiments have been conducted under the immediate supervision of Dr. E. A. de Schweinitz, assisted by Drs. Marion Dorset and E. C. Schroeder, and the publication of the results obtained will furnish a convenient and desirable method of preserving and distributing the results of scientific investigations in this important part of the work of this Bureau.

Very respectfully,

D. E. SALMON,
Chief of Bureau.

Hon. J. STERLING MORTON,
Secretary of Agriculture.

LETTER OF SUBMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
Washington, D. C., July 1, 1896.

SIR: I herewith submit for publication some results of investigations upon the cultivation of the tuberculosis bacillus upon acid media, the innocuous character of an attenuated tuberculosis bacillus, and some further experiments with reference to the effect of tuberculin upon the milk of cows. Charts showing the average temperature reactions of cattle as regards breed are also appended.

Respectfully,

E. A. DE SCHWEINITZ,
Chief Biochemic Division.

Dr. D. E. SALMON,
Chief of Bureau of Animal Industry.

CONTENTS.

Page.
The growth of the tuberculosis bacillus upon acid media. By E. A. de Schweinitz, Ph. D., M. D., and Marion Dorset, M. D. 7
Introduction 7
Observations 8
Details of experiments 9
Further experiments with an attenuated tuberculosis bacillus. By. E. A. de Schweinitz, Ph. D., M. D., and E. C. Schroeder, M. D. V 11
Experiment with a monkey 11
Results of guinea pig inoculations 12
The effect of tuberculin injections upon the milk of healthy and diseased cows. By E. A. de Schweinitz, Ph. D., M. D 15
Analyses of milk of cows injected with tuberculin 18
Temperature reactions of the cows used in the milk experiments 19

test was not satisfactory in the beef broth, the albuminoids and possibly organic acids present evidently interfering with the reaction. The phloroglucin and vanillin test, however, proved conclusively the presence of free hydrochloric acid in the media, upon which there was a good growth of the tuberculosis bacillus. The exact quantity of the free hydrochloric acid present in these cultures could not be readily determined, as when hydrochloric acid was added to the media a portion apparently first decomposed the organic salts and phosphates.

After the growth of the tuberculosis germ is well advanced upon the media described and has apparently ceased, the acid reaction of the cultures is still more marked, requiring for the neutralization of the acid substance produced by the germ to every 100 c. c. of culture 12.5 c. c. to 15 c. c. $\frac{N}{10}$ sodium hydrate.

Lubinski notes a decided variation in the morphology of the germ as grown upon the acid vegetable broth. The bacilli, he says, often appear in long filaments, having, however, the same thickness that the germs usually possess. The filament forms described by Metschnikoff, Fischel, and Jones varied in thickness, showed side chains, and were not joined, while Lubinski reports characteristic streptococci-like formation. Jones could find this filamentous growth only after the cultures were four to five months old. Lubinski observed it in ten days.

OBSERVATIONS.

Our observations upon the character of the germs grown upon acid beef broth media and their morphological changes are somewhat different. Instead of a thread-like growth or chain growth we have often found what appeared to be spores, and sometimes the bacilli seem very much thicker and longer than the ordinary germs. In one culture examined the germ had been from generation to generation during four years grown on acid media and might be expected to show Lubinski's chain-like formation, but instead there was an apparent spore formation perceptible.

The appearance of the germs grown upon our acid media can be seen from the accompanying plates. Pl. I, fig. 1, shows the bacillus grown upon glycerin beef broth for four months; Neisser's spore stain. Pl. I, fig. 2, shows the bacillus grown for forty generations upon an acid media.

The filament forms are not observed. There is a slight thickening of the bacillus and rounding at the end often noted, which would appear to be spore formation. There is a different change in the morphology of the germ as grown upon our media which confirms the conclusions of Lubinski that we have heteromorphic forms of the tuberculosis bacillus and a genuine pleomorphismus caused by the changed conditions of life. Bruns (Centralblatt für Bak. und Parasitenkunde, Bd. XVII, Abth. I, No. 23) describes a germ which gives Neisser's spore reaction and in particular evidently corresponds to the ones we have pictured.

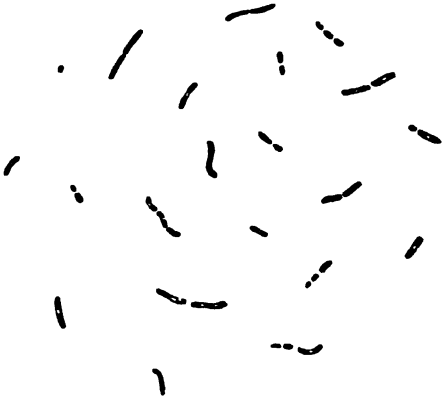


FIG. 1.- Seventh generation in glycerine beef broth. Neisser's spore stain. (× 2000.)

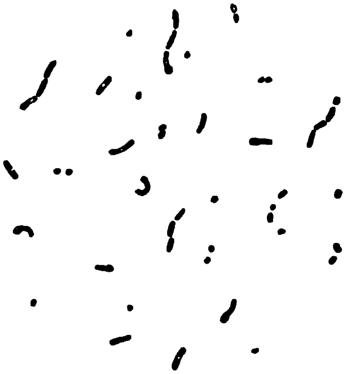


FIG. 2. Fortieth generation, acid media. Neisser's spore stain. (× 2000.)

Haines, del.

BACILLUS TUBERCULOSIS UPON NEUTRAL AND ACID MEDIA.

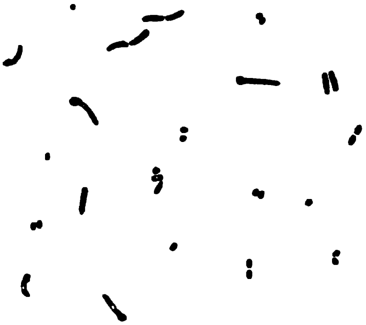


FIG. 1.—Culture containing free hydrochloric acid. Neisser's spore stain. (×2000.)

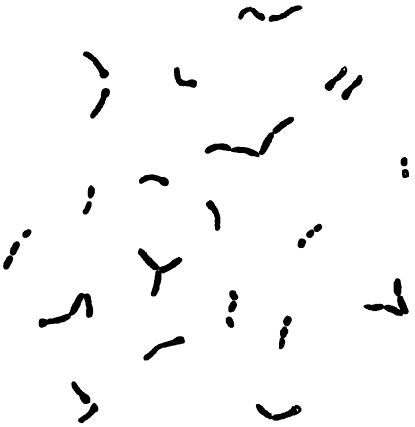


FIG. 2.—Artificial culture. Neisser's spore stain. (×2000.)

Haines, del.

BACILLUS TUBERCULOSIS UPON ACID MEDIA CONTAINING FREE HYDROCHLORIC ACID, AND UPON ARTIFICIAL MEDIA.

Pl. II, fig. 1, shows the germ grown upon acid media containing free hydrochloric acid.

Pl. II, fig. 2, is a drawing of the tuberculosis germ grown on artificial media. We do not here observe quite the same change in the morphology of the germ.

DETAILS OF EXPERIMENTS.

A more detailed description of our experiments may be interesting. The reaction of the media prepared for the cultivation of the tuberculosis germ was not changed in the process of sterilization. A quantitative check of the amount of acid was made before and after this process.

First experiment.—The media used for this experiment was alkaline and required for neutralization 1 c. c. $\frac{N}{2}$, hydrochloric acid for every 50 c. c. of the media.

a. To each of 2 flasks 50 c. c. each, 5 c. c. $\frac{N}{10}$, NaOH were added.

b. To each of 2 flasks 50 c. c. each, 20 c. c. $\frac{N}{10}$, NaOH were added.

c. To each of 2 flasks 50 c. c. each, 1 c. c. $\frac{N}{2}$, HCl were added.

The six were inoculated at the same time with tuberculosis bacilli from (A 14). Within two weeks a good growth of the germ was noted over the surface of flasks *a* and *c*, while *b* showed no growth at all.

Second experiment.—The media used required for neutralization 8.4 c. c. $\frac{N}{10}$, sodium hydrate solution for every 50 c. c.

a. To each of 2 flasks 50 c. c. were added 8.4 c. c. $\frac{N}{10}$, NaOH.

b. To each of 2 flasks 50 c. c. were added 1.3 c. c. $\frac{N}{2}$, HCl.

a flasks were neutral and *b* flasks acid. The two sets were inoculated from the same culture (A 15). Within two weeks the germs in both flasks were growing well, *a* perhaps a trifle better than *b*. At the end of seven weeks one flask, *a*, was titrated and required for neutralization 6.3 c. c. $\frac{N}{10}$, NaOH. This flask had been neutral when inoculated. *b* flasks required 22.5 c. c. $\frac{N}{10}$, NaOH for neutralization. The increase in acid in *a* flasks is represented, therefore, by 6.3 c. c. $\frac{N}{10}$, NaOH, and in the *b* flasks by 7.5 c. c. $\frac{N}{10}$, NaOH. There was apparently a larger amount of the acid substance formed in the acid flasks than in those which were neutral at the time of inoculation.

Third experiment.—The media used required for neutralization 6.6 c. c. $\frac{N}{10}$, NaOH for every 100 c. c. of liquid.

a. To each of 2 flasks 100 c. c., 1 c. c. $\frac{N}{2}$, HCl was added.

b. To each of 2 flasks 100 c. c., 2 c. c. $\frac{N}{2}$, HCl were added.

c. To each of 2 flasks 100 c. c., 3 c. c. $\frac{N}{2}$, HCl were added.

These flasks were all inoculated with a virulent germ, and although it required several weeks for the growth to begin, after four weeks there was growth in all of the cultures, the most acid ones seeming to contain as good a growth as the others. Every 100 c. c. of the *a* media had required 11.6 c. c. $\frac{N}{10}$, NaOH.

Every 100 c. c. of the *b* media had required 16.6 c. c. $\frac{N}{10}$, NaOH.

Every 100 c. c. of the *c* media had required 21.6 c. c. $\frac{N}{10}$, NaOH for neutralization.

Fourth experiment.—The media used in this experiment was the artificial media described by one of us—De Schweinitz—in 1892, and it required 45 c. c. $\frac{N}{10}$, NaOH for every 100 c. c. for neutralization.

a 100 c. c. one flask of the media as noted.

b 100 c. c. one flask of the media as noted with the addition of 2 c. c. $\frac{N}{2}$, hydrochloric acid.

These were inoculated from another artificial culture, and both within fifteen days showed a good growth, the one containing hydrochloric acid showing a slightly better growth than the other.

Drs. Trudeau and Baldwin have pointed out that the apparent retardation of the growth of the tuberculosis bacillus by the acid reaction of the media can be overcome by neutralization. This is true; but we have also found that if the germ is transferred from an acid culture after it has been cultivated on acid media for a number of months to a neutral nutrient fluid it will no longer grow. There would seem from this to be probably a poisonous principle secreted by the germ. It may be a true acid or, more likely, a substance with an acid reaction. In the experiment, as the germs used for inoculation still floated on the surface of the culture they should have been alive unless some substance especially inimical to their growth was produced in the cultures.

These experiments show clearly that the tuberculosis bacillus can be readily accustomed to an acid nutrient fluid, that it can easily adapt itself to the changed conditions of life, and that even a small amount of free hydrochloric acid does not interfere with its growth. They tend to show further, we think, that under certain conditions there is probably a poisonous substance produced by the germs which is inimical to their own life.

The adaptability of the bacillus to a variety of media can best be explained by spore formation.

MARCH 14, 1896.

FURTHER EXPERIMENTS WITH AN ATTENUATED TUBERCULOSIS BACILLUS.

By E. A. DE SCHWEINITZ, Ph. D., M. D., and E. C. SCHROEDER, M. D. V.

In the Medical News, December 8, 1894, one of us (E. A. de Schweinitz) briefly described an attenuated tuberculosis bacillus (human), and noted that while originally very virulent, by a special method of cultivation it had been rendered very harmless, and not only failed to produce disease in guinea pigs and rabbits, but in some instances imparted to animals inoculated with it a distinct resistance to tuberculosis upon a subsequent inoculation with a virulent germ. The experiments with this attenuated germ have been continued, and we desire to present further evidence of the apparent absolutely harmless character of this attenuated germ, reserving for a later article further reports of its immunizing properties.

EXPERIMENT WITH A MONKEY.

After a number of guinea pigs and cattle had been inoculated with this attenuated germ it seemed desirable to test its effect upon an animal susceptible to tuberculosis and more like man. Accordingly a monkey placed at our disposal by Dr. Kinyoun was inoculated on September 10, 1895, with ¼ c. c. of an emulsion of a tubercle culture thirtieth generation. The inoculation was made from a culture in which there was an active growth.

On September 28, 1895, the injection with this material ½ c. c. of tuberculosis culture thirty-second generation was repeated, and again on January 20, 1896, 2 c. c. of tubercle culture thirty-third generation. At the seat of the first and second injections small nodules were formed, while no local lesion was noted at the seat of the third injection.

On April 9 the monkey was found dead. It had not been well for three weeks and was quite sick during the five or six days immediately preceding death. It had no appetite, the hair was rough, there was nausea and great thirst and evidence of distress. Post-mortem examination revealed congested lungs and an inflammatory condition of ileum and caecum. Dr. Schroeder says "there were no signs of tuberculosis and the small nodules formed at the time of the first two injections had become absorbed." This attenuated germ was, therefore, innocuous to the monkey, though, as noted before, it had been obtained from an originally very virulent germ.

RESULTS OF GUINEA PIG INOCULATIONS.

The guinea pig inoculations made by one of us (Schroeder) with this attenuated germ to test its virulence were as follows: November 24, 1894, Nos. 280, 281, 282, and 283 received each an abdominal injection subcutaneously of ½ c. c. tubercle culture twenty-third generation.

On January 25, 1895, each pig again received 1 c. c. tubercle culture twenty-sixth generation. October 7, 1895, guinea pig No. 281 was found dead. A small dry, cheesy nodule at the seat of one injection was noted, but there was no other evidence of tuberculosis, and death resulted from inflammation of the bowels.

On January 3, 1896, guinea pig No. 282 was found dead from pneumonia. There was no evidence of tuberculosis. The other two pigs, Nos. 280 and 283, are alive and well at this time.

Guinea pigs Nos. 55, 56, 57, 58, and 59 were inoculated on October 2, 1895, subcutaneously with 1 c. c. tubercle culture thirty-second generation. On October 17 guinea pig No. 55 was found dead, and post-mortem revealed a general inflammatory condition of subcutaneous tissue over entire abdomen. The other animals, Nos. 56, 57, 58, and 59, are alive and well at this writing.

Again, January 25, 1895, guinea pigs Nos. 331 and 332 were inoculated with ½ c. c. tubercle culture twenty-sixth generation. On December 30, 1895, guinea pig No. 331 was found dead from pneumonia. The liver had a peculiar mottled appearance and a few yellowish patches. Though a coverglass preparation showed no tubercle bacilli, two pigs, Nos. 121 and 122, were inoculated as checks with a portion of the liver. After the lapse of six months they are alive and well and show no symptoms of disease.

On February 19, 1895, guinea pig No. 332 was also found dead, death being due to inflammation of the bowels, and there was no evidence of tuberculosis.

These inoculations made by Dr. Schroeder have confirmed the earlier experiments made by Dr. De Schweinitz, and agree with the following which have been repeated as a check on the first work. They show conclusively that from an originally virulent germ we have succeeded in obtaining an attenuated germ which, even in large doses, is apparently harmless to guinea pigs, rabbits, cattle, horses, and monkeys.

November 15, 1895, six guinea pigs were inoculated with ¾ c. c. each of an emulsion of an attenuated culture thirty-fourth generation. The pigs weighed as follows:

	Ounces.		Ounces.
No. 67	9	No. 70	11½
No. 68	11	No. 71	8½
No. 69	11	No. 81	12

November 18 No. 67 was found dead from pneumonia. The other animals exhibited the following condition on subsequent dates:

December 13, 1895.

Guinea pig.	Weight.	Remarks.
	Ounces.	
No. 68	12	Slight local swelling; no enlarged glands.
No. 69	14	Do.
No. 70	13	Do.
No. 71	10	Slight local swelling; right inguinal gland enlarged.
No. 81	14	Slight local swelling; no enlarged glands.

December 31, 1895.

Guinea pig.	Weight.	Remarks.
	Ounces.	
No. 68	14	Slightly enlarged glands.
No. 69	16	No enlarged glands.
No. 70	15	Do.
No. 71	11	Do.
No. 81	14	Slightly enlarged gland.

No tuberculosis was evident on autopsy of one of these, showing that the germ was without pathogenic effect. The animals had steadily gained in weight.

Again:

Guinea pig.	Weight.	Guinea pig.	Weight.	Guinea pig.	Weight.
	Ounces.		*Ounces.*		*Ounces.*
No. 166	15	No. 170	14	No. 174	15
No. 167	13	No. 171	11	No. 176	14
No. 168	14	No. 172	16	No. 159	10
No. 169	10	No. 173	16	No. 164	10

These animals were all inoculated on February 5, 1896, with 1½ c.c. of attenuated tuberculosis culture thirty-seventh generation. On February 13, 1896, the weights of these animals were as follows:

Guinea pig.	Weight.	Remarks.
	Ounces.	
No. 169	9	Swelling size of a pea at point of inoculation.
No. 172	15½	Do.
No. 174	15	Do.
No. 159	10	Do.
No. 170	12¼	Large swelling at point of inoculation.
No. 168	14	Slight swelling at point of inoculation.
No. 171	10	Do.
No. 173	14	Do.
No. 164	8	Slight swelling; pneumonia.
No. 166	14	Do.

On February 8 and 10, respectively, guinea pigs No. 167 and 176 were found dead from pneumonia, which they had contracted from exposure to cold. Subsequently guinea pigs Nos. 174, 172, 159, and 171 were found dead from pneumonia. On March 16, 1896, guinea pig No. 169, which had been inoculated on February 5, with the attenuated germ was found dead. There were no signs of tuberculosis, although the animal had been inoculated over a month. The pig died from pneumonia. March 10, 1896, the record of the remaining animals was as follows:

Guinea pig.	Weight.	Remarks.
	Ounces.	
No. 173	15	Slight sore at point of inoculation.
No. 169	9	No local lesion.
No. 168	16	Slight sore at point of inoculation.
No. 170	10	Apparently well.
No. 166	14	Do.

Guinea pig.	Weight.	Guinea pig.	Weight.	Guinea pig.	Weight.
March 18, 1896:	*Ounces.*	March 23, 1896:	*Ounces.*	April 7, 1896:	*Ounces.*
No. 168	16	No. 170	10½	No. 168	18
No. 170	10	No. 168	16½	No. 166	16
No. 173	14	No. 166	16	No. 170	10
No. 166	14	No. 173	13½	No. 173	12

There was no enlargement of the glands indicating the beginning of tuberculosis, and, except a loss of weight in pigs Nos. 170 and 173, which was suspicious, there was no evidence of tuberculosis.

These and other cases in which the guinea pigs were inoculated with the attenuated germ, and after one to two years showed no evidence of disease, have proved conclusively the attenuated character of this germ. Although this germ is so attenuated and innocuous to animals, its ability to grow in artificial media is as good and better than ever, and the tuberculin obtained from its culture is as satisfactory as that prepared from a more virulent germ.

Cows and calves have also been inoculated with this attenuated germ in doses varying from 2 to 500 c. c. at a time without the production of tuberculosis. Nodules were frequently formed at the point of inoculation, which seemed, however, to be due to the mechanical action of the germ, and did not produce any evidence of tuberculosis.

JUNE 29, 1896.

THE EFFECT OF TUBERCULIN INJECTIONS UPON THE MILK OF HEALTHY AND DISEASED COWS.

By E. A. DE SCHWEINITZ, Ph. D., M. D.

Continuing the line of experiments given in my report, Bulletin No. 7, Bureau of Animal Industry, upon the variation in the amount of fat in the milk before and after the injections of tuberculin, tests were made on different dates upon a healthy cow, No. 299, with varying doses of tuberculin, upon diseased animals Nos. 145 and 161, and also upon a set of eight different animals taken from the same milch herd—Nos. 185, 186, 187, 189, 194, 195, 222, and 234. The latter had all been condemned by the tuberculin test, and preparatory to their being killed were kept at the station for some days, thus giving an opportunity for testing their milk. There was practically no variation in the fat of the milk from the healthy cows after the tuberculin injection. This agrees with our first experiments, and also with some tests made by Dr. Law, reported in Cornell University Bulletin No. 7. Neither was there any alteration when, as is seen from the tests in March on No. 299, large doses, 30 c. c. of tuberculin, were injected. The second and third injection with tuberculin of No. 145 and 161, diseased respectively, caused no appreciable rise of temperature, but there was a decided decrease in the amount of fat.

In the series of January 16, 1895, however, the two animals that showed no rise in temperature failed to show any decrease in the milk fat. When the rise of temperature was noted in the others a marked decrease in fat was also noted.

A comparison of the decrease in fat with the extent of the disease, as revealed by autopsy and given me by Dr. Smith, except in case No. 234, a generalized one, does not apparently show any relationship. The oldest cases seemed to give the least change in fat—No. 185—while the newer cases gave the largest variation. The Tables I and II show the quantity and composition of the various samples of milk, and the Tables III and IV the temperature reactions after the tuberculin injection, for the corresponding dates.

No. 285, an animal condemned for tuberculosis about a year ago, has been kept at the station since that date. At first she was injected with small doses of tuberculin until she ceased to give a reaction and was again apparently well. The injections of tuberculin were increased in number and quantity, and on March 20, 1895, the date of the last examination of the milk, the animal received an injection of 100 c. c.

Previous to that date she had received altogether 565 c. c. of tuberculin. The last injection caused no change in the amount of fat or in the temperature.

The variation in fat should, of course, be attributed in part to the fever. But that this is not the only cause is also evident. The variation is not, judging from the few tests made, sufficient of itself to prove the presence of tuberculosis, but taken in conjunction with the rise of temperature might be considered as corroborative evidence. The tuberculin tests were made by Drs. Schroeder and Curtice, while in the milk analyses I was assisted by Mr. J. A. Emery.

In this connection are appended several charts with curves which show the average variation in temperatures of a number of different animals. These were tabulated in February, 1895, from the reports received from the different States to which tuberculin had been sent.

Chart No. 1 shows the average temperature of a number of animals, without reference to breeds. The other charts are arranged so that all animals of the same breed are placed together. The diagnoses were not in all cases proved by slaughtering the animals, but in all cases where they were killed the autopsies confirmed the diagnoses.

The weights of the animals were taken as the average weight, and the dose of tuberculin was 2 c. c. The Holstein cattle showed apparently a slightly higher reaction than the others. The temperature curve begins at the time of injection, and the first temperatures then noted are six hours after the injection with tuberculin.

The upper line in the charts shows the reaction of the diseased animals, and the lower of healthy ones. In order to make the charts smaller, an average was made of the temperatures of the different animals taken before the injection. From four to eight temperatures were taken of each animal, and the general average thus obtained with a large number of animals is given as the average normal temperature.

In the chart giving the curve for the whole number of animals there is a rise of temperature noted after twenty hours. This is due to the Holstein chart, which is included. The late reaction noted in these animals, which were from different herds, may be due to their larger size.

Many objections have been made against the use and reliability of tuberculin as a diagnostic agent, the opposition coming principally from those who are to a great extent unfamiliar with its practical use or who are only too ready to condemn a material which, through lack of skill and knowledge on their part, has perhaps given unsatisfactory results. The committee in Paris, composed of Cheveau, Leblanc, Mequin, Nocard, Strauss, Trasbot, and Weber, reported as follows upon the principal objections to the use of tuberculin: "The use of high temperatures and carbolic acid in the manufacture of tuberculin makes it impossible that the tuberculin, if properly prepared, should produce disease. It occasionally happens that tuberculin fails to give a reaction in diseased animals, but these are very exceptional cases, and occur only sometimes when the animals are very badly diseased and their condition could be easily recognized, and are not of importance. Occasionally, also, apparently healthy animals show a reaction, but when a very thorough and careful autopsy is made evidence of the disease is usually found. In a case of an apparently healthy animal, therefore, one can only say in safety that the examination had not been sufficiently close to discover the lesions. Again, in cases where there was apparently some other disease and the tuberculin injection caused a reaction a careful autopsy has shown the presence of tuberculosis, and that the reaction was due to the latter disease." This disposes of the objection that the tuberculin reaction is not characteristic.

The statement that the tuberculin injection causes the disease to spread more rapidly is not warranted by facts, and in many instances the use of tuberculin has apparently caused an improvement in the disease.

One animal, originally tuberculous, kept at the station of the Bureau of Animal Industry, has received about 3,000 c. c. tuberculin in different injections, extending over a long time. This animal is now well and fat and has entirely recovered from tuberculosis.

In 1895 the International Congress for Veterinary Medicine, at Berne, said: "Tuberculin is a most excellent diagnostic material, and can be of the utmost service in the warfare against tuberculosis." This resolution was indorsed by the French Academy of Medicine and the use of tuberculin was generally recommended. The satisfactory reports received from the different States to which this Bureau has sent tuberculin are confirmatory of the results obtained, and prove that tuberculin is the only effective means at hand to insure a rapid eradication of tuberculosis in cattle. A table showing the results of the tuberculin injection of more than 50,000 cattle will appear in the next Annual Report of the Bureau.

FEBRUARY, 1895.

TABLE I.—*Analyses of milk of cows injected with tuberculin.*

No. of animal.	Date.	Quantity.	Specific gravity.	Total solids.	Sugar.	Albuminoids.	Fat.	Ash in milk.	Total fat acid. (*a*)	Volatile fat acid. (*b*)	Acidity. (*c*)
	1894.	*c. c.*		*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*c. c.*	*c. c.*
299	Dec. 11	9,655	1.032	13.65	3.84	3.14	4.48	0.70	....	6.7	0.132
	Dec. 12	9,655	1.031	14.54	4.17	2.91	6.31	.70	....	5.0	.146
	Dec. 13	8,519	1.029	13.38	3.84	2.90	5.10	.62	....	3.9	.108
	Dec. 14	9,087	1.029	13.11	4.16	2.86	4.10	.66	....	6.6	.112
	Dec. 18	7,950	1.028	12.74	3.33	2.50	5.49	.60	....	4.7	.132
145	Dec. 11	2,000	1.018	21.61	5.00	3.21	15.34	.75	....	3.5	.100
	Dec. 12	1,785	1.025	14.68	2.94	3.13	7.73	.75	....	3.9	.136
	Dec. 13	3,407	1.026	14.95	2.38	3.49	7.16	.72	....	5.0	.130
	Dec. 14	3,407	1.027	15.03	3.12	3.51	7.21	.76	....	4.8	.134
	Dec. 18	3,407	1.027	16.26	2.77	3.75	8.18	.78	....	4.8	.114
161	Dec. 11	450	1.020	18.86	2.50	3.98	12.56	1.01	....	2.8	.072
	Dec. 12	1,025	1.027	12.99	2.63	3.05	5.52	.77	....	5.5	.072
	Dec. 13	1,703	1.026	12.77	2.77	2.99	4.09	.74	....	7.5	.102
	Dec. 14	1,703	1.026	12.92	2.94	3.06	4.91	.73	....	6.1	.110
	Dec. 18	1,703	1.026	13.73	2.63	3.16	6.35	.81	....	5.1	.090
	1895.										
299	Jan. 3	10,222	1.034	12.61	3.57	2.78	4.26	.73	....	3.3	.140
	Jan 4	9,087	1.033	12.34	3.57	2.81	3.30	.76	....	....	.150
	Jan. 8	10,222	1.032	12.45	3.57	2.96	3.87	.69	....	7.2	.168
	Jan. 9	9,087	1.034	12.58	3.84	2.13	3.86	.67	....	7.2	.156
	Jan. 10	9,654	1.033	12.95	3.84	2.51	4.06	.61	....	7.5	.154
145	Jan. 3	3,407	1.028	16.97	2.77	3.36	10.14	.86	....	1.4	.100
	Jan. 4	3,407	1.030	15.40	3.12	3.05	7.37	.76	....	1.9	.156
	Jan. 8	3,691	1.030	15.68	3.12	3.56	7.44	.75	....	1.9	.122
	Jan. 9	3,407	1.031	16.74	2.94	3.80	8.35	.73	....	4.9	.138
	Jan. 10	3,123	1.028	15.38	3.12	3.58	6.54	.70	....	5.3	.138
161	Jan. 3	1,703	1.030	17.54	2.94	3.48	9.99	.77	....	1.4	.130
	Jan. 4	1,992	1.027	13.27	3.12	2.97	5.77	.83	....	2.0	.132
	Jan. 8	2,272	1.029	14.37	2.94	3.20	6.53	.68	....	....	.124
	Jan. 9	1,988	1.031	14.63	3.33	3.35	6.52	.70	....	4.9	.130
	Jan. 10	1,987	1.031	14.57	3.33	3.28	5.91	.71	....	5.3	.124
299	Feb. 18	8,234	1.031	11.90	3.33	2.59	3.96	.68	28.39	7.4	.128
	Feb. 19	8,519	1.033	12.14	3.57	2.61	3.66	.68	30.83	7.7	.132
	Feb. 20	8,234	1.032	12.33	3.57	2.63	4.07	.68	30.60	7.0	.150
299	Mar. 4	8,519	1.031	12.29	3.57	2.72	3.87	.67	29.21	7.2	.154
	Mar. 5	8,945	1.032	11.99	3.57	2.68	3.46	.68	40.63	8.2	.156
	Mar. 6	....	1.032	12.20	3.57	2.09	3.56	.69	38.25	7.4	.160
	Mar. 8	9,087	1.032	11.98	3.57	2.61	3.25	.69	38.81	7.5	.156
285	Mar. 19	4,828	1.029	12.84	3.57	3.01	5.14	.67	27.89	5.8	.106
	Mar. 20	5,112	1.029	14.60	3.57	3.12	6.73	.67	27.21	5.2	.096
	Mar. 21	5,396	1.029	13.59	3.57	3.03	5.81	.66	22.99	5.1	.098

a Iodine absorption number.

b Number of cubic centimeters, $\frac{N}{10}$ Ba (oH)$_2$, required for 1 gram of fat.

c Number of cubic centimeters, $\frac{N}{10}$ Na oH, required for 1 cubic centimeter of milk.

TABLE II.—*Analyses of milk of cows injected with tuberculin.*

185.				189.				222.			
Date.	Quantity.	Specific gravity.	Fat.	Date.	Quantity.	Specific gravity	Fat.	Date.	Quantity.	Specific gravity.	Fat.
	c. c.				*c. c.*				*c. c.*		
Jan. 14	5,111	1.029	5.92	Jan. 14	9,655	1.030	4.28	Jan. 14	5,111	1.024	10.87
Jan. 15	4,260	1.028	5.51	Jan. 15	7,950	1.028	4.29	Jan. 15	5,111	1.024	8.20
Jan. 16	4,543	1.030	5.50	Jan. 16	7,083	1.030	3.67	Jan.. 16	4,827	1.030	5.09
Jan. 17	4,543	1.030	5.71	Jan. 17	7,667	1.028	4.29	Jan. 17	3,692	1.029	6.53
Jan. 18	4,260	1.029	5.77	Jan. 18	7,667	1.027	3.68	Jan. 18	6,247	1.029	6.12
186.				194.				229.			
Jan. 14	....	....	....	Jan. 14	1,420	1.028	10.83	Jan. 14	2,556	1.023	9.03
Jan. 15	375	1.028	5.51	Jan. 15	1,704	1.025	11.06	Jan. 15	5,679	1.022	8.22
Jan. 16	500	1.022	9.04	Jan. 16	1,998	1.029	6.53	Jan. 16	5,111	1.027	4.91
Jan. 17	568	1.022	7.19	Jan. 17	2,272	1.030	6.73	Jan. 17	4,260	1.027	6.95
Jan. 18	440	1.024	6.97	Jan. 18	1,948	1.031	5.09	Jan. 18	6,816	1.029	4.28
187.				195.				234.			
Jan. 14	1,998	1.030	8.77	Jan. 14	5,111	1.024	6.01	Jan. 14	5,111	1.023	8.42
Jan. 15	3,123	1.023	12.32	Jan. 15	1,704	1.027	7.97	Jan. 15	4,543	1.023	6.36
Jan. 16	3,407	1.028	6.13	Jan. 16	2,272	1.029	4.49	Jan. 16	3,692	1.030	2.44
Jan. 17	3,408	1.030	7.51	Jan. 17	1,998	1.028	8.17	Jan. 17	3,975	1.027	7.36
Jan. 18	3,408	1.031	6.16	Jan. 18	2,556	1.030	6.52	Jan. 18	5,111	1.027	5.93

TABLE III.—*Temperature reactions of the cows used in the milk experiments.*

Date.	Time.	No. 299.	No. 161.	No. 145.
1894.				
Before injection.		°	°	°
December 11	1.00 p. m.	102.3	101.3	101.6
	3.00 p. m.	102.0	98.2	97.3
	5.00 p. m.	101.5	99.4	98.5
After injection.				
December 12 (injected 2 c. c. tuberculin at 8 p. m. December 11)	8.00 a. m.	101.0	101.0	101.4
	10.00 a. m.	100.8	101.2	101.0
	12.00 m.	101.2	100.6	102.5
	2.00 p. m.	101.0	102.0	101.2
	4.00 p. m.	101.4	101.0	101.6
1895.				
Before injection.				
January 7	1.00 p. m.	101.0	102.4	100.6
	3.00 p. m.	101.0	102.6	101.2
	5.00 p. m.	101.2	102.7	101.4
After injection.				
January 8 (injected 2 c. c. tuberculin at 8 p. m. January 7)	8.00 a. m.	101.5	101.8	105.2
	10.00 a. m.	101.0	101.7	105.0
	12.00 m.	100.4	100.8	102.6
	2.00 p. m.	101.4	101.0	101.5
	4.00 p. m.	101.3	101.5	101.1
Before injection.				
February 18	9.00 a. m.	101.6	....	....
	12.00 m.	100.6	....	....
	4.00 p. m.	101.9	....	....
	9.00 p. m.	101.2	....	....
After injection.				
February 19 (injected 2 c. c. tuberculin at 9 p. m. February 18)	8.00 a. m.	101.6	....	....
	9.00 a. m.	102.7	....	....
	10.00 a. m.	102.6	....	....
	11.00 a. m.	100.2	....	....
	12.00 m.	100.2	....	....
	1.00 p. m.	101.2	....	....
	2.00 p. m.	101.5	....	....
	3.00 p. m.	101.8	....	....
	4.00 p. m.	101.8	....	....
	5.00 p. m.	101.4	....	....
Before injection.				
March 4	8.30 a. m.	101.2	....	....
	12.00 m.	100.2	....	....
	4.30 p. m.	101.2	....	....
After injection.				
March 5 (injected 30 c. c. tuberculin March 4)	8.00 a. m.	101.5	....	....
	9.00 a. m.	102.0	....	....
	10.00 a. m.	99.2	....	....
	12.00 m.	100.2	....	....
	2.00 p. m.	101.2	....	....
	4.00 p. m.	101.5	....	....
	5.00 p. m.	101.9	....	....

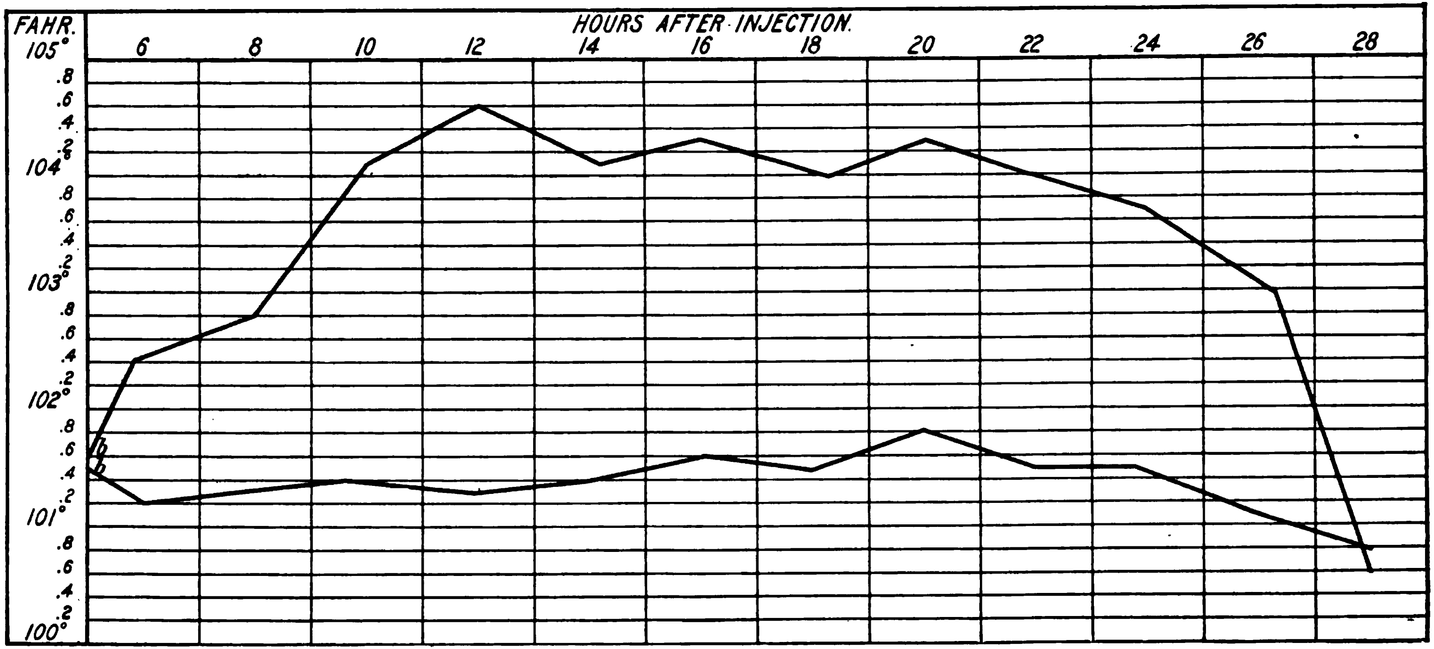
TABLE IV.—*Temperature reactions of the cows used in the milk experiments.*

[First test of tuberculous cows.]

Date.	Time.	No. 185.	No. 186.	No. 187.	No. 189.	No. 194.	No. 195.	No. 222.	No. 229.	No. 234.
1894.										
Before injection.		°	°	°	°	°	°	°	°	°
December 7.............	9.00 p. m.	102.0	100.5	100.2	101.5	101.2	102.5	102.2	101.3	103.9
After injection.										
December 8 (injected 2½ c. c. tuberculin 11 p. m. December 7)..........	8.00 p. m.	102.4	101.2	101.3	102.0	102.0	105.8	102.6	105.4	103.0
	9.00 p. m.	103.1	101.4	100.3	101.8	103.8	107.0	103.6	104.8	103.6
	10.00 p. m.	105.3	103.2	102.4	104.8	104.0	107.2	104.6	103.4	103.8
	11.00 p. m.	105.6	105.6	102.1	105.8	103.8	107.2	106.4	106.2	104.8
	12.00 m.	106.6	106.0	101.5	106.6	104.3	107.4	106.2	106.9	104.5
	2.00 a. m.	106.0	105.6	99.7	106.4	106.1	106.7	106.5	106.5	105.2
	4.00 a. m.	105.4	105.1	104.7	105.6	105.2	105.3	105.0	105.4	105.7
	8.00 a. m.	103.0	106.2	104.8	105.6	102.0	104.2	105.2	104.4	104.7
	10.00 a. m.	101.0	100.5	101.0	100.5	101.0	101.1	101.0	100.4	102.6
[Second test of tuberculous cows.]										
1895.										
Before injection.										
January 15	4.00 p. m.	102.2	102.5	101.8	102.8	102.0	101.4	101.4	101.6	100.2
	9.00 p. m.	102.0	101.8	100.8	102.5	101.8	101.8	101.0	101.0	101.4
After injection.										
January 16 (injected 2 c. c. tuberculin 11 p. m. January 15)...........	8.00 a. m.	101.5	102.0	99.6	102.0	102.6	105.2	104.7	103.2	105.3
	8.30 a. m.	101.8	103.2	101.0	102.0	101.8	105.2	105.2	104.0	105.4
	9.00 a. m.	102.4	103.2	101.2	103.3	102.6	105.2	105.2	104.6	105.4
	9.30 a. m.	102.2	103.5	101.2	103.2	102.8	105.3	105.4	105.4	105.8
	10.00 a. m.	102.2	103.6	101.2	103.4	102.8	105.4	105.3	105.2	106.0
	10.30 a. m.	102.2	103.0	101.6	104.2	103.0	105.2	106.0	105.5	106.0
	11.00 a. m.	102.4	103.2	101.5	104.6	104.2	105.1	106.0	105.6	106.2
	11.30 a. m.	102.6	102.9	101.2	104.2	104.4	105.0	104.6	105.4	106.4
	12.00 m.	103.0	102.8	103.2	104.2	104.4	104.8	105.3	105.6	106.3
	12.30 p. m.	103.6	102.6	103.6	104.6	104.3	104.6	105.5	104.8	106.2
	1.30 p. m.	103.5	103.0	103.9	104.8	104.6	104.5	105.5	105.2	106.0
	2.00 p. m.	103.4	102.0	104.5	104.8	104.6	104.0	104.6	104.6	105.6
	2.30 p. m.	103.6	101.6	104.6	104.4	104.2	104.0	103.4	103.5	105.2
	3.00 p. m.	102.4	100.0	105.0	100.0	102.8	103.4	103.5	102.4	104.6
	3.30 p. m.	101.9	99.5	105.0	99.6	102.4	103.0	103.2	102.5	104.2
	4.00 p. m.	101.6	99.3	104.6	99.4	102.0	103.2	103.2	102.6	104.0
	4.30 p. m.	102.8	99.6	104.5	99.4	102.0	103.0	103.2	102.6	104.2

FIG. 1.—*Chart showing average temperature of 3,930 healthy and 1,191 diseased cattle injected with tuberculin.* (*a*)

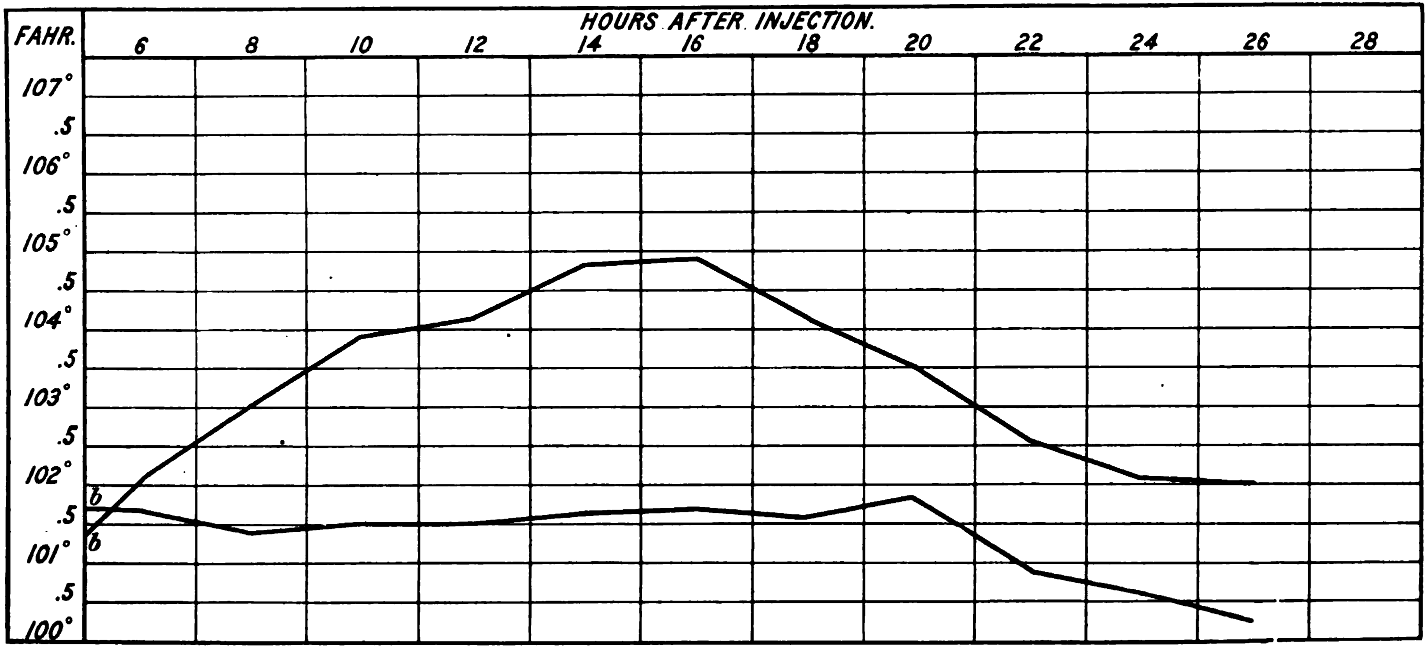
[Average normal temperature of 1,191 tuberculous cattle before injection, 101.6° F. Average normal temperature of 3,930 healthy cattle before injection, 101.5° F.]



a Tabulated in February, 1895. *b* Temperature at time of injection.

FIG. 2.—*Chart showing average temperature reaction of 62 tuberculous and 93 healthy registered Jerseys; 71 tuberculous and 303 healthy grade Jerseys; 98 tuberculous and 195 healthy Jerseys injected with tuberculin.* (*a*)

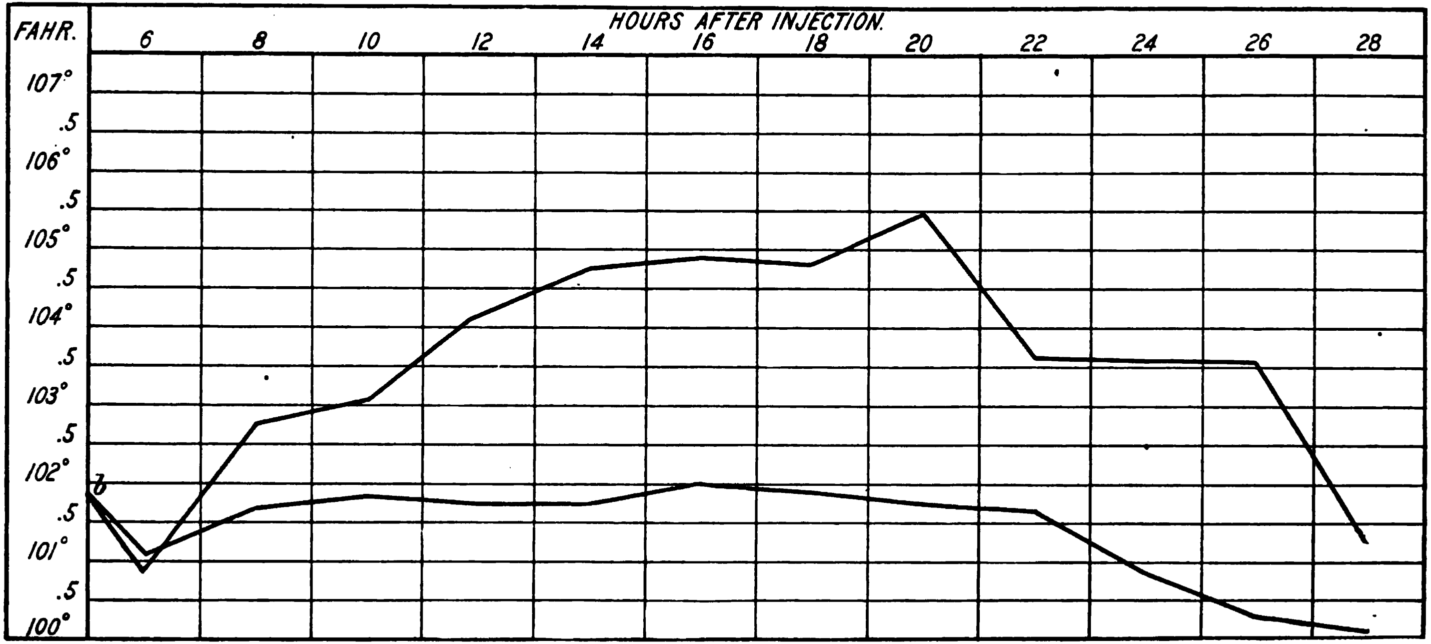
[Average normal temperature of 231 tuberculous cows before injection, 101.4° F. Average normal temperature of 591 healthy cows before injection, 101.7° F.]



a Tabulated in February, 1895. *b* Temperature at time of injection.

FIG. 3.—*Chart showing average temperature reaction of 40 tuberculous and 68 healthy grade Holsteins; 70 tuberculous and 104 healthy Holsteins injected with tuberculin.* (*a*)

[Average normal temperature of 110 tuberculous cows before injection, 101.8° F. Average normal temperature of 172 healthy cows before injection, 101.8° F.]



a Tabulated in February, 1895.

b Temperature at time of injection.

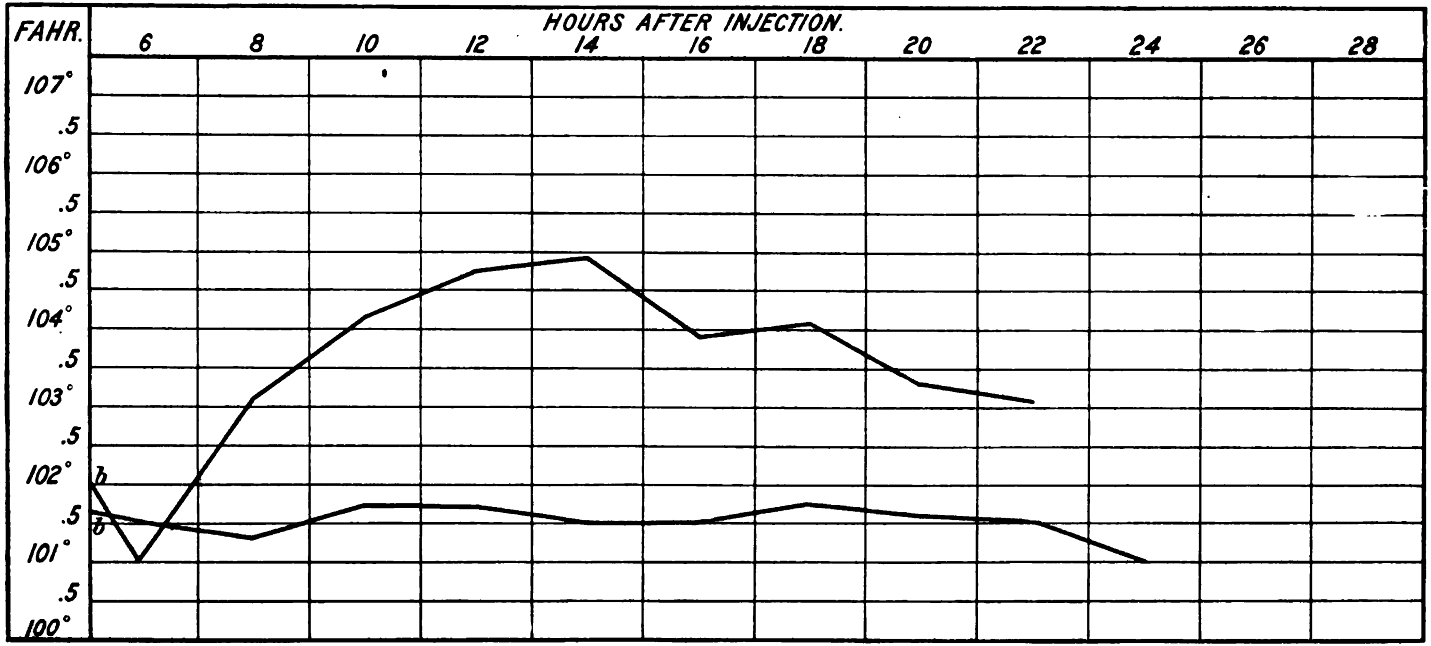


FIG. 4.—*Chart showing average temperature reaction of 37 tuberculous and 64 healthy Durhams; 5 tuberculous and 11 healthy grade Durhams injected with tuberculin.* (*a*)

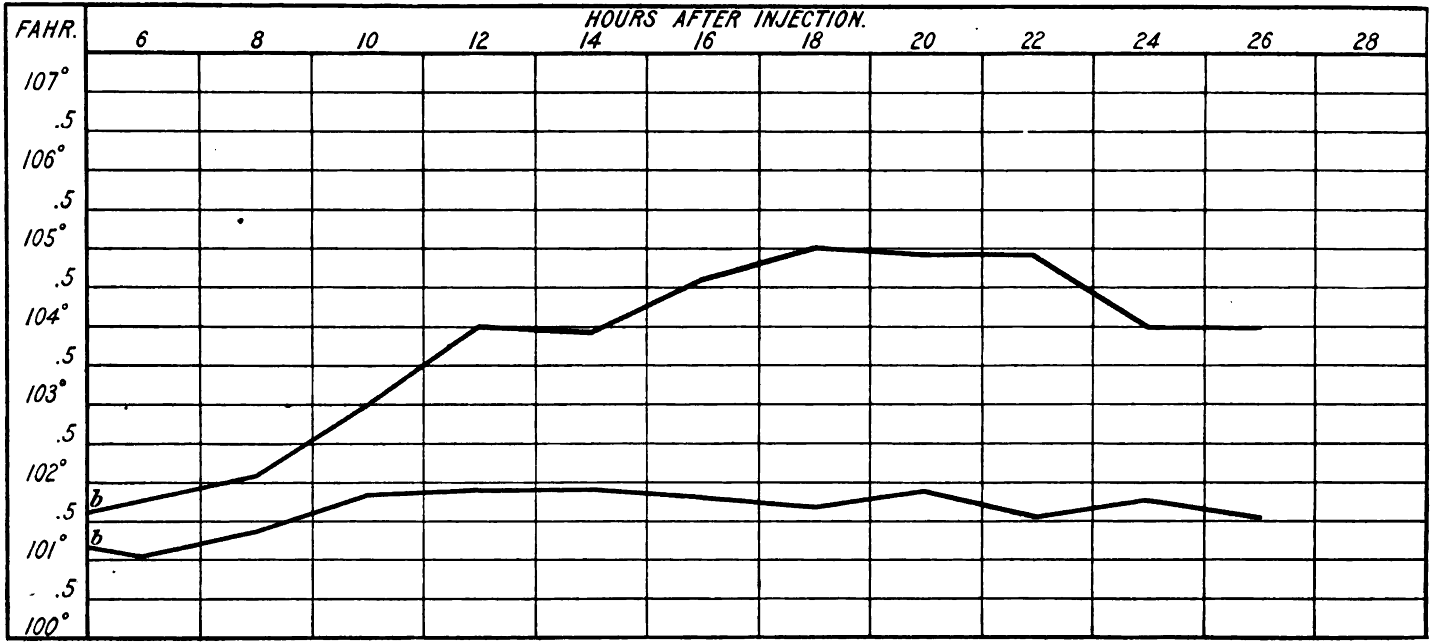
[Average normal temperature of 32 tuberculous cows before injection, 102.1° F. Average normal temperature of 75 healthy cows before injection, 101.6° F.]

a Tabulated in February, 1895.

b Temperature at time of injection.

FIG. 5.—*Chart showing average temperature reaction of 15 tuberculous and 24 healthy Ayrshires injected with tuberculin.* (*a*)

[Average normal temperature of 15 tuberculous cows before injection, 101.6° F. Average normal temperature of 24 healthy cows before injection, 101.2° F.]



a Tabulated in February, 1895. *b* Temperature at time of injection.

BULLETIN NO. 14. (Dairy No. 5.)

U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF ANIMAL INDUSTRY.

DAIRYING IN CALIFORNIA.

BY

PROF. E. J. WICKSON, M. A.
UNIVERSITY OF CALIFORNIA.

Under the direction of
Dr. D. E. SALMON,
Chief of the Bureau of Animal Industry.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1896.

LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
Washington, D. C., July 15, 1896.

SIR: I have the honor to transmit herewith for publication, as a bulletin of this Bureau, the manuscript of a report, prepared under the direction of Henry E. Alvord, Chief of the Dairy Division, by Prof. E. J. Wickson, special agent of that division, on the history, development, and present condition of the dairy industry in California. The report is of general interest, and contains many suggestions for practical dairymen operating under very diverse conditions.

Very respectfully,

D. E. SALMON,
Chief of Bureau.

Hon. J. STERLING MORTON,
Secretary of Agriculture.

CONTENTS.

Page.

Historical 5

  Establishment of the dairy industry by Americans 5

  Early practices and prices in the coast region 6

  More recent aspects of the industry 7

Widely diverse dairy conditions in California 8

Four main divisions of California dairy lands and climates 8

The leading dairy county of California 13

California system of large dairy holdings 13

Capacity of California dairy lands 14

The dairy breeds in California 15

Dry feed and its characteristics 15

Pasturage seasons in California 16

The milking season and winter feed 17

Succulent food during the summer drought 18

The best drought-resisting forage plants 18

Winter shelter in California 19

Watering dairy stock 20

Months of greatest production and the yield per cow 20

Number of creameries in California 21

Wide use of centrifugal separators 22

Length of season and Sunday work 23

Milk values in different months 23

Proportion of creamery patrons 24

Distance of milk carriage 24

Farm dairies in California 24

The California butter roll 26

California forms of cheese 26

Dairy markets of California 27

Eastern shipment of California butter 29

Dairy organization and protection 30

ILLUSTRATION.

Fig. 1.—Map of California 9

DAIRYING IN CALIFORNIA.

HISTORICAL.

The grazing interests of California were established by the Franciscan friars who began their missionary effort for the Christianization of the Digger Indians in 1769 at San Diego. In 1697 their predecessors, the Dominicans, located their first mission on the peninsula of Lower California, and a year later brought thither horses and cattle from Mexico. The offspring of this introduction came northward with the Franciscans and were the progenitors of the vast herds which supplied hides and tallow for a large export trade and were the main source of subsistence for a considerable population of mission wards and Mexican settlers previous to the American occupation. Some idea of the extent of this grazing interest can be gained from the fact that in 1834, after the missions had passed the highest period of their prosperity, their property included 424,000 cattle; 62,500 horses, mules, and asses, and 325,000 sheep, swine, and goats. These figures do not include the property of the settlers away from the missions, nor the countless bands of wild cattle and horses which roamed the plains without mark of ownership. But while cattle were thus abundant and labor was to be had for the commanding, there was practically no dairying. The narratives of travelers state that milk was rare, but the poorest settler had plenty of beef in his pot. Even the goats must have been of very low dairy grade, for one visitor, while acknowledging that the goats were milked, adds that it was difficult to get a pint of milk from six of them. The mission padres had plenty of olive oil to take the place of butter, and wine instead of milk. The Mexican settlers, with few exceptions, did not relish the labor which was required to produce wine and oil and therefore drank water until trade brought them stronger substitutes.

With the American occupation, and notably with the inrush of gold-seekers in 1849, a sharp dairy demand arose. This was supplied in great measure by importation, as will be shown presently, but it called into existence local dairying, the development of which was marked by novel features which invite brief description.

ESTABLISHMENT OF THE DAIRY INDUSTRY BY AMERICANS.

The beginnings of California dairying were made in two regions considerably remote from each other—the mining region amid the foothills of the Sierra Nevadas, which form the eastern boundary of the State, and the seaboard region adjacent to San Francisco, which lies upon our western boundary. The latter region was destined to achieve great commercial importance, but there was no lack of characteristic uniqueness in the former. Many families of gold seekers who took up the march for the California gold fields from their homes on the prairies of the West, camped their way across the plains, subsisting in part upon the milk of the family cows which they drove before them. Reaching the mines, they found that the milk they had been using so freely would command an almost incredible amount of gold from the miners, and while the male members of the family engaged in mining direct, the female members often gained more dust by caring for and selling the product of their cows. Fresh milk and fresh butter brought them immediate and continued prosperity. Favorable lands were selected, and in these mountain homes grew up large herds and finally valuable dairies which formed the nucleus of the mountain dairy district, which will be mentioned in another connection. This pioneer dairy effort was established with cows bred to milk and with the ordinary dairy skill of the eastern half of the country nearly half a century ago.

EARLY PRACTICES AND PRICES IN THE COAST REGION.

The dairy industry of the coast region of the State was established upon a different basis. The early projector had here a wider opportunity in the demands of the thousands who arrived in San Francisco by sea. The supply of dairy goods consisted of butter and cheese by ship around the Horn from Boston and New York, or was gathered up at South American ports, where only the rudest dairying was practiced. These supplies were inferior to begin with, and were rendered almost inedible by the deteriorating influences of long sea voyages. Almost anything in the form of butter and cheese, freshly made, was greedily welcomed. Money was plentiful, and fresh butter commanded $1.50 and cheese 40 cents per pound. But there were hardships in the way of production, even at these prices. Few cows were to be had except those of the hide-and-tallow breed of the Mexicans. To get any milk at all, this cow had to be lassoed and tied to a stake and allowed the company of her calf before a drop could be secured. Very soon, too, even these unprofitable animals became scarce, because of the vast inroads upon the available beef supply made by the hungry hordes of miners. High beef prices induced the driving westward of large herds of cattle from the Western States and from Texas, and this introduction brought to the pioneer dairyman stock which was poor enough from a dairy point of view, but still vastly better than that of the Mexicans. This movement of cattle soon proceeded beyond local needs for beef and prices ran low, but the inferiority of the stock as dairy producers was clear, from the fact that while the best of the 4-year-olds could be bought for $10 each, and pasturage was almost free, the price of butter was 38 cents and of cheese 15 cents per pound. But if the cattle were bad, the dairy practice was a match for them. Nothing better than the roughest sheds were used to shelter the milk and dairy apparatus and to cure the cheese, and the cattle had no shelter whatever. The mild climate made this possible. The products themselves fluctuated in a way almost incredible. As late as 1858 cheese made from skimmed milk and sweet buttermilk combined sold at 25 and 27 cents per pound the same day it was taken from the hoop, and butter brought $1 a pound. Within two years these prices were quartered and the ruling rates were counted unprofitable, as indeed they were under the conditions then prevailing.

Under these circumstances the poorest dairymen went into other pursuits and the poorest cows to the butcher. Men with some dairy insight pushed forward into better systems of operation, cows were selected and trained for dairy production, pasture lands were purchased or leased in large areas, and the California system of large private ownership of lands and cows, with leaseholds to operating tenants, arose. This system of dairying with leased lands and cows will be described later.

MORE RECENT ASPECTS OF THE INDUSTRY.

During the decade following 1860 dairy operations were greatly extended. There were very wide fluctuations in market values, and there were serious losses of stock from drought, which the dairymen had not yet learned to provide against; but, on the whole, the business was very profitable, although still very wastefully conducted. The extent of the demand can be seen from allusion to importations. From 1860 to 1865 the importation of butter steadily increased, until in the latter year there was more than 6,700,000 pounds imported, for which more than $2,000,000 was paid. Local production soon began to supplant this importation, but there was about an average of a million pounds of butter brought in by ship each year for several years thereafter. The completion of the overland road also ministered to the supply from distant sources, and during the fall and early winter of each year considerable quantities of oleomargarine and creamery butter from the Chicago region were brought to San Francisco.

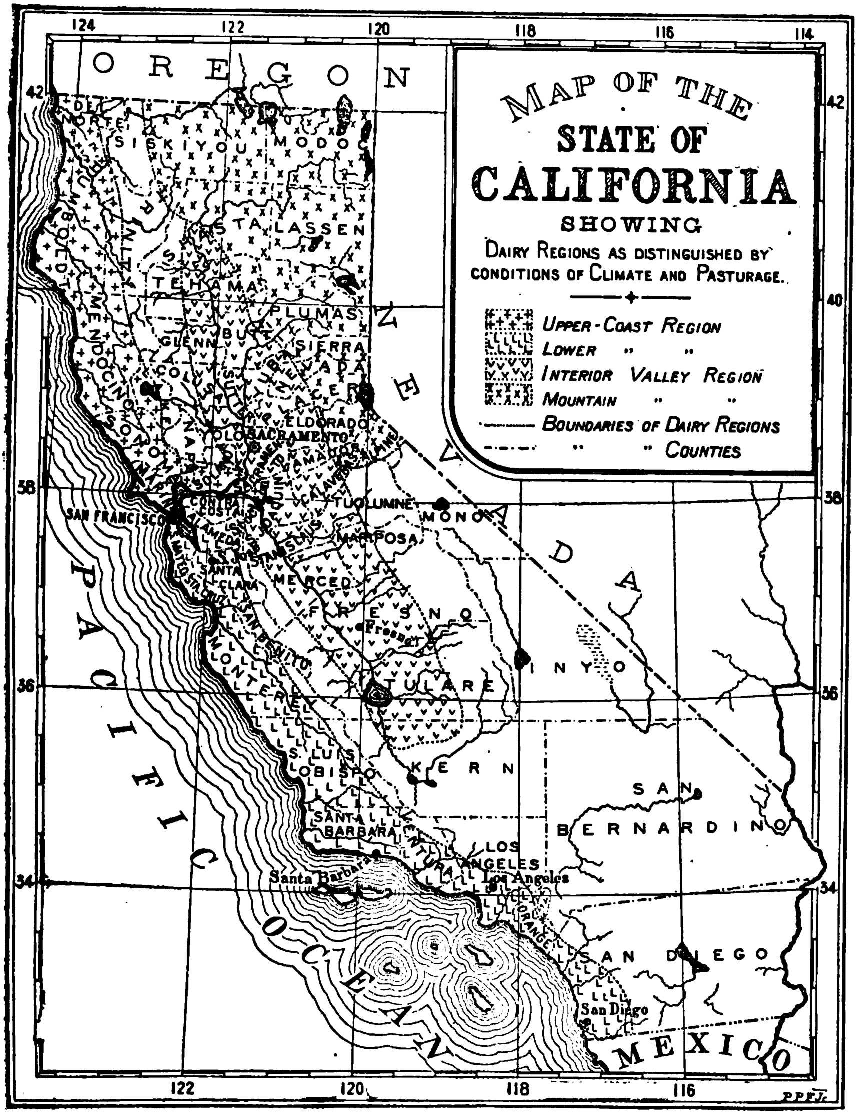
Cheese was also largely brought in by ship and rail during the earlier years of California's growth, and, in fact, it was not until about 1878 that local production reached the amount of local needs. From that time to the present there has been a surplus for distant shipment. Until about 1890 this was fairly well disposed of at different places on the coast where new cities were springing up, and where mining, lumbering, and railroad building enterprises were being carried on in advance of dairy development in the immediate localities. At the present time these distant parts of the coast are developing their own dairy resources, and, instead of buying from California, are marketing their surplus so far as possible in California cities. California dairymen have met these changed conditions by the old and accepted dairy weapons, viz, organization for the improvement of practice and the resulting cheapening and higher quality of the product. Thus the creamery system has come to California sometimes as a graft upon the old system of large private dairies, sometimes as supplementary or as a substitute therefor, as will be presently described.

WIDELY DIVERSE DAIRY CONDITIONS IN CALIFORNIA.

Natural conditions affecting dairy practice in California are widely diverse and necessitate differences in practice in nearly all departments of dairy work, from the selection of forage plants and the care of stock, all the way through the dairy curriculum to the manufacture and care of the product. There is no such variation on the Atlantic Slope; but one can find something analogous in European conditions if he take into account the mountain dairying of the Alpine valleys, the moist, diked lands of Holland, the heated, irrigated plains of Italy, and the coast lands of Normandy, with their perennial pastures born of equable temperature, abundant rains, and fog. Close resemblances to all these various conditions can be found within the boundaries of California, and they must be taken into account in any successful attempt to describe the geographical features of the dairy industry in this State. With this fact in view, it is possible to lay down four chief divisions of California dairy lands, based upon a similarity of natural conditions within each of them. These divisions or regions do not comprise compact geographical areas, but are rather long, narrow bands or belts taking an extended range from north to south, with comparatively short east and west extensions. The governing factors, in their demarcation, are: Proximity to the coast, elevation and local topography, rainfall, and other climatic features. The intrusion of some of these factors makes it impossible to follow exactly geographical lines in defining the regions. For ordinary uses, however, they may be arranged as follows: (1) Upper coast, (2) lower coast, (3) interior valley, (4) mountain valley.

FOUR MAIN DIVISIONS OF CALIFORNIA DAIRY LANDS AND CLIMATES.

(1) The upper coast region comprises the counties north of San Francisco which lie west of the Coast Range Mountains and have a salt-water frontage either upon the Pacific or the Bay of San Francisco, or upon both. These are the counties of Marin, Sonoma, Mendocino, Humboldt, and Del Norte on the ocean, and Contra Costa, Solano, and Napa counties on the bay. In the ocean-side counties the dairy is a leading interest, while in the bay counties it is subsidiary. This region is the oldest dairy district in the State, and it is still in the lead both in extent of production and in the employment of progressive methods. The natural conditions for dairying are unsurpassed. The length of the rainy season gives a natural pasturage longer than can be found elsewhere in the State, and the amount of rainfall is such that there never has been a serious drought.



Extreme length	770 miles.
Length of coast line	1,097 geographical miles.
Length of coast line	1,280 statute miles.
Breadth, narrowest part	150 miles.
Breadth, widest part	330 miles.
Contains	156,592 square miles.

On the immediate coast summer fogs refresh the pastures and ocean influences prevent extreme temperatures at any season of the year. Water is, as a rule, abundant and pure, and the soils exceedingly productive of clovers and grasses as well as of cultivated crops for supplementary feeding.

(2) The lower coast region is usually taken to include all the lands on or near the coast from San Francisco southward to San Diego, a distance of, approximately, 500 miles. This region also lies west of the Coast Range—that is, between the main chain of the Coast Range and the ocean—and is therefore subject to ocean influences in varying degrees, increased by proximity to the shore or lessened by distance or by the intervention of ranges of hills, which act as barriers to the progress of ocean winds and fogs. In this extended region the annual rainfall decreases as you go southward at the rate of about 2½ inches to each 100 miles of distance, and the average temperature increases about 1 degree for each 100 miles. This variation is regulated by local topography to a certain extent, but the general change is as noted. Naturally the northern half of this region is the greater in dairy production. The counties of San Mateo, Santa Cruz, Monterey, San Luis Obispo, and the northern half of Santa Barbara have the dairy as a leading industry, with San Luis Obispo at the front. In favorable years this county has made a record as the banner butter county of the State. Also included in this dairy region are the counties of Alameda and Santa Clara, bordering on the Bay of San Francisco, but within their boundaries horticultural production far exceeds the dairy. The same is true of the southern half of Santa Barbara, Ventura, and San Diego counties, while Los Angeles and Orange counties, by virtue of large areas of low, moist land adjacent to the ocean, market a very large dairy product in addition to a large output of fruits and grains from higher lands. Though this coast dairy region south of San Francisco is thus seen to be notable in its adaptation and development in dairy lines, it is inferior to the coast region north of San Francisco, because of its less moisture and greater heat, its shorter pasturage season, its liability to occasional droughts, which about once in a decade have caused serious loss of stock as well as product, and the need of greater effort to produce supplies of supplementary feeds; and yet through the introduction of better system and wiser foresight in dairy operations these difficulties and dangers give infinitely less concern than they did in former years.

(3) The interior valley dairy region comprises lands removed from coast influences. They are situated on the east side of high elevations of the Coast Range, which largely exclude ocean winds and fogs, including all the counties lying in the valleys of the San Joaquin and the Sacramento rivers and their tributaries. These areas comprise one great valley between the foothills of the Sierra Nevada on the east and the Coast Range on the west. It is, approximately, 400 miles long and varies in width from 40 to 60 miles. The valley region also

includes some areas in southern California at a distance from the coast, but owing to the eastward trend of the high Coast Range in southern California conditions are not quite the same. Here and there gaps in these mountains open a path eastward for ocean temperatures and moisture and give to adjacent lowlands a mixture of coast and valley conditions, so that one region intrudes upon the territory of the other. This is notable where the Sacramento and San Joaquin rivers break through the Coast Range to reach San Francisco Bay and where the Salinas and Pajaro rivers flow into Monterey Bay. At these points ocean influences extend far into the interior, being, however, progressively ameliorated by interior heat and drought, as they proceed. The valley region proper does not include these modified areas, and is distinctly free from coast influences except those which surmount the ranges and thus have an effect upon the climate of the whole State. The leading characteristics of the interior valleys are high summer heat and very dry summer air; very small and uncertain rainfall, consequently frequent and severe droughts; a very short season of succulent pasturage, except on irrigated or low, moist river-bottom lands of comparatively small area; scant water supply and that of undesirable warmth; occasional presence of insects in grievous numbers. In short, in their natural conditions these interior valleys are unfitted for dairy husbandry except during the winter, when, if the rainfall be adequate, there is a very free growth of rich pasturage and the temperature conditions are excellent for dairy work.

In these arid lands progressive dairying has made its greatest achievements. The introduction of irrigation and the growth of alfalfa and other plants impossible without it; the use of centrifugal separators to secure the cream which could not be raised in good condition by the gravity method because no refrigerating agency could be had cheaply enough for general use; the construction of buildings excluding high temperatures and the employment of devices for cooling by evaporation of moisture—in fact, by meeting unfavorable conditions at all points by ingenuity and the employment of the latest dairy inventions, dairy manufacturing in the interior of California has been made practicable and profitable, and many lessons can be learned from it for the guidance of practice in other heated, arid regions. As a matter of recent history, it may be added that these interior regions, which were once almost wholly dependent upon the coast and the mountains for their dairy supplies, are now producing for distant shipment.

In all the interior valley region, however, both north and south, differences are in degree rather than in kind, and in all of them the use of naturally moist or irrigated land and advanced dairy practice are the ruling factors of success. Although this region is of vast area, only a small fraction is as yet employed in dairying. Fruit and grain are the chief products, but the dairy would increase as the irrigated area is extended if adequate market demand were assured. At present this does not seem to be the case.

(4) The mountain valley dairy region of California is quite distinct in its characteristics from any of those already mentioned, and it approaches more nearly than any of them to a likeness to the dairy conditions and practice of the Eastern States. In one sense the mountain region is supplementary to the interior valley region, because there began very early in the development of the State an itinerant system of dairying in which the cows were driven back and forth from valley plains to mountain meadows, wintering in the valley and summering in the mountains. This practice chiefly prevailed in the northeast quarter of the State, and while uninclosed public lands yielded abundant free pasturage and prices were high, it was very profitable. As a system it was quite analogous to the Alpine dairying of Switzerland. More recently the occupation of public lands and other adverse conditions have reduced the practice, but some dairymen have permanent locations both below and above, and still migrate twice a year. The system does not favor the use of improved methods and can not long survive.

This is, however, only one phase of mountain dairying, and now the least important one. The early demonstration of the good points of the mountain district was followed by the permanent establishment of dairying. The natural pasturage is superior, and moisture in summer favors the growth of some standard dairy grasses which do not thrive elsewhere in California; the streams and springs run cold water; natural ice can be had, and deep setting in coolers is feasible.

On the other hand, a winter of snow and ice makes the Eastern methods of stock shelter and provender imperative, and distance from market and wagon transportation of products place the producer at something of a disadvantage. While good dairy markets in the mining towns of Nevada could be had, this was not of so much importance, but now that these towns have declined and Nevada has become a shipper of dairy produce to California markets the situation of the mountain dairymen is less satisfactory. The mountain region is, however, one of great reserve force, and in the future growth of the coast will have better opportunity to exercise its excellent productive ability and to use its rich resources. The mountain counties which have made the best records in mountain dairying are Sierra and Plumas, although other counties both north and south of them also have important dairy interests and resources. Siskiyou and Shasta counties have thriving local dairy establishments which find a market in adjacent mining regions. Lassen and Modoc counties have large grazing and grain interests, and with better transportation facilities could largely increase their dairying. The higher elevations of Placer, Nevada, Eldorado, and, in a less degree, Amador and Alpine, have good mountain pastures which are partially utilized, while Mono and Inyo, the only counties in California east of the Sierra Nevada Mountains, have a considerable surplus dairy product which reaches market by means of a railway running thence into Nevada.

THE LEADING DAIRY COUNTY OF CALIFORNIA.

The foregoing sketch of the dairy regions of California includes mention of the counties which lead in this industry. The greatest of all the counties in amount of product, in number of modern establishments, and first in the construction of a modern creamery, is Humboldt County, with a butter product of 2,843,452 pounds in 1892. Although the county has other very important interests, it is the estimate of several well-informed persons that over one-half the population is concerned in dairying, and in some parts of the county quite three-fourths of the people are thus engaged. Probably Humboldt, and Marin in a less degree, are the only counties in which such high percentages rule, but there are parts of other counties in which similar proportions could be given. California has always been marked by local specialization of products. This is to some degree a rational deduction from clearly discerned differentiation in local climates, and in some degree attributable to popular conceptions of greatness in farming policy. It was a very early notion in California that the farming operations of an individual must necessarily cover a vast area of land. It was easy to acquire such areas in early days, and the influence of such acquisitions and of farming methods required by them is still strong, though its departure can now be clearly foreseen. Aside from this, however, there is good reason for much specialization, because conditions change so greatly. On the moist lands of Orange County, for instance, probably about one-third of the people are engaged in dairying, while on the adjacent higher lands there is not only little dairying but probably many of the fruit-growers who use those lands do not even keep family cows.

CALIFORNIA SYSTEM OF LARGE DAIRY HOLDINGS.

The size of the dairy farms and the number of cows to each vary within wide limits. As stated, the old plan was to have very large herds and farms; but the old plan was also to have rather small dairy buildings and enough of them. They were so located that part of the cows could be conveniently driven to each for milking, and a butter or cheese maker was located at each of these branch establishments. As each of these branches must have its own foreman and cook, as well as its own gang of milkers, it was soon seen that a system of tenantry would both relieve the owner and inspire the foreman to watchfulness and zeal. It would also be economical to have the foreman's wife for cook. The result was that a lease price was put upon the branch at so much per cow furnished by the owner, the lessee to furnish his own labor, force, and utensils, and to raise an agreed number of calves each year for the owner; the owner to keep up the number of good cows and to furnish materials for necessary fencing and buildings, for the construction of which the tenant supplied the labor. The tenant paid a cash rent; consequently the produce of the dairy and the swine yard belonged to him, and there was no division of products to worry about. While dairy prices were good this arrangement was mutually satisfactory to owner and lessee, and with a good large herd of cows the latter was able to secure an income which enabled him to hire all the labor necessary to maintain his family in good style and have a comfortable bank account, which allowed the purchase of good appliances, etc. In this way the system of large single dairies came about in California. Some tenants handled as many as 300 cows and manufactured as much milk as the smaller cooperative establishments at the East received from their patrons. The lease rate per cow naturally declined with the coming of lower values for dairy produce from the old range of $25 to $30 to the present rate of $16 to $20. The tenants' net income declined even more notably. The result has been that many American tenants have saved themselves by introducing creamery outfits, while others gave way to Europeans, who could live on narrower margins and were able to secure labor of their own nationality for less than the former tenants paid. Some of these European dairymen are very bright and enterprising men, and now figure as large dairy proprietors and leaders in the commercial as well as the producing branches of the industry; others are very ignorant and too often squalid, and form a decided barrier to local dairy progress.

Although large dairy holdings still prevail in the older regions, there has been, during the last twenty years, great increase in the number of small dairy farms, and this has been due in part to the subdivision and sale of the old holdings and in part to the advance of the interest into newer parts of the State. The present range of herd numbers of creamery patrons in several counties is as follows:

County.	Average number of cows to the farm.
Siskiyou	30
Humboldt	40
Mendocino	25
San Luis Obispo	75
Santa Barbara	100
Los Angeles, Orange, and San Bernardino	12

CAPACITY OF CALIFORNIA DAIRY LANDS.

The number of acres required for the keeping of a cow in California is determined by local conditions of soil and climate. There are cases in which 1 acre to the cow can be cited, and others in which 2 and even 3 acres are allotted to the cow in estimating the capacity of pasturage. Beyond this there are pastures so scanty that the growth on 5 acres will not exceed the wants of a single animal. The best records are made in the moist, rich, coast valleys of Humboldt County and on the alfalfa lands in the irrigated or the naturally moist sections of the interior valley. Two instances are given by correspondents in Eel River Valley, Humboldt County, viz: Mr. A. Kansen, of Ferndale, keeps 35 cows on 34 acres, secures an average yield of 300 pounds of butter and buys no feed whatever. The cows are on pasture nine months of the year, and for the other three they are fed hay and roots, all grown on the 34 acres. J. E. Brown, also of Ferndale, keeps 35 cows on 40 acres, his average yield and feeding being like the preceding. These records are strictly credible when one knows the natural pasturage conditions prevailing and the favoring climate. The cows are simply good selected grades of dairy breeds. The average in the dairy sections of Humboldt County, that is, on the best of the valley lands, is 1½ acres to a cow.

THE DAIRY BREEDS IN CALIFORNIA.

Although all the leading dairy breeds have secured introduction to California, only three have made a wide and enduring impression on the ordinary run of dairy cattle. They are, both in historical order and extent of influence, as follows: The Shorthorn, the Jersey, and the Holstein-Friesian. The Ayrshire, the Devon, the Guernsey, and others only show their impress in localities adjacent to the few imported herds; they have never taken widely. On the other hand, one can hardly go into the dairy regions anywhere without being able to recognize the marks of the three breeds first named. The Shorthorn gave the first great improvement on the common stock, which was, as already stated, of mixed Mexican and American origin. The breeding of dairy families of Shorthorns has continued with due enterprise and care, and sires of such parentage have always been in request. The Jerseys next secured wide introduction on the basis of cream and butter points, and the Jersey cross became very popular and is still largely used. Then came the Holstein-Friesians, with their great milk yield, and many dairymen, who desired to correct the tendency to decreased size resulting from the Jersey cross, used the black-and-white stock to increase size and capacity. This comment fairly represents the popular conception among dairymen of the relations of these three breeds. We have, of course, individuals who adhere strongly to continuous use of sires of the same breed, and others who rely upon continuous selection from dairy stock of uncertain ancestry. On the whole, the dairy stock of the State is of very good quality and capacity.

DRY FEED AND ITS CHARACTERISTICS.

In the descriptions of the dairy regions of California previously given, there are references to the different lengths of the natural pasturage season in each. Those remarks apply to the natural growth of succulent pasturage. Besides this, there is in California what is locally known as "dry feed," which is quite an important factor in all branches of our live-stock husbandry. This dry feed is simply the growth of grasses and clovers which have naturally matured by the advancing drought of the summer season, and constitute, therefore, an unmown hay on which the animals subsist. It will occur to the distant reader that it would be better to cut and stack this hay when it is in its best condition than to allow it to desiccate in the sun and wind. Of course, when such wild growth is in suitable quantity on lands convenient to mow, this course is often taken nowadays, but the growth on hillsides or in canyons and the aftermath of low-growing grasses and clovers would cost more than it would yield in the mowing, and much of it, like the rich seed pods of the bur clover (*Medicago denticulata*) and other short growth of leaf and seed, could not be secured by any machinery except the oral outfit of the grazing animal. Besides this, dried herbage is richer in nutritive materials than a stranger might think, because its maturity is forced upon it by the heat and drought, and it retains such richness in its dried fibers that it is not at all to be compared with the dead grasses of humid climates. The most obvious demonstration of this fact is the sight of cattle, sleek and fat, on brown fields, apparently, too, as bare as they are brown, gaining full nourishment from the rubbish-like seeds and dry herbage spread over the sun-baked soil.

PASTURAGE SEASONS IN CALIFORNIA.

Speaking generally, the growth of grass in all parts of California, except the mountain region, begins with the fall rains. These rains come from the north and occur first in the upper coast region and then in the northern half of the interior valley region. The mean date for this opening of the growing season in northern California is October 8. Later the lower coast region is reached, and after that the southern half of the interior valley region, the mean date being November 1 for the southern half of the State. The ideal, or as common parlance goes, the "good year" is one in which the rains occur at short intervals, so that continuous pasture growth is maintained after the naturally sown seeds are once germinated. In such a year the cattle are wading knee-deep in succulent vegetation from January until May. The landscape is carpeted with the varied hues of wild flowers, the cattle are sleek, and the flow of milk is forced by agreeable temperatures and a wealth of juicy forage. Except on pastures heavily overstocked there comes after the rains are over a good amount of dry feed, already described, and the scattering of enough seed to insure a good start of plants at the coming of the following fall rains.

This is the "good year" during which the stock find abundant feed in the field for the full twelve months, and it is this good year which is to be credited with both the fullness and the lack in California dairying. The good year does not always come, and the modifications of it are sometimes trying. The rains, which sometimes come too early, may be followed by two months of drought; they have given moisture enough to spoil the dry feed and to start the seeds of the new growth which the drought destroys. This time the fields are really bare and yield no forage, and the dairyman having learned to trust in a good year, has to risk this year's profit by buying feed which he ought to have grown, and would have grown if he had not indulged the illusion that he would not need it. In his dairy economy he has planned to have his milk flow come with the new grass, and his cows shrink because, instead of full pasturage, they are given a scant ration of hay, which is doled out because the backwardness of the pastures has induced an unusual demand and a consequent advance in the price of hay.

Again, perhaps the season may depart from the ideal because of excessive rains and cold, driving storms in which his cattle suffer from exposure for lack of shelter, which the counting on a good year has convinced him was unnecessary. Again, there may be a departure in the shape of unusual succession of frosts and possibly a snow flurry, and then the cattle suffer both from scant growth of herbage and lack of shelter. It is because of this too great trust in California skies and winter fields that the old style of open-air dairying is often disappointing. It is a mark of the present progressive dairying to provide extra feed and shelter and good dairy buildings generally, because they are a surety against loss, although they may not always be required.

THE MILKING SEASON AND WINTER FEED.

These statements are necessary to an understanding of the length of our pasturage season and the vicissitudes which attend it. The length of the milking season will average about nine months; in many of the better herds it is ten months, and that is about the period which is aimed at by others who do not quite attain it. On the other hand, in some of the remote counties, the cows divide their time about equally between resting and milking. In such cases the cows have to "rustle" for feed and shelter during the winter, and are milked only during the grass season of the higher altitudes.

In all except the mountain region the length of the pasturage season is about nine months; and though usually the cattle are kept afield the whole twelve months, for about three months they are given some supplementary feed. In dairies adjacent to San Francisco and Los Angeles, and here and there elsewhere, there are dairymen who find it profitable to follow modern methods in using rations of various purchased feedstuffs in connection with hay and pasturage, but over the greater part of our dairy area the cows have only what the ranch produces. In the alfalfa districts they have alfalfa pasturage in summer and alfalfa hay in winter, for this plant does not make a good winter growth, though in the same regions there is often a growth of salt grass, which adds succulence to their hay ration. In the coast regions, where alfalfa does not find the heat it desires, dependence is placed upon hay of the wild, winter growths, or of barley or wheat cut before ripening. In Humboldt and Del Norte counties, as well as along the moist river lands of the central part of the State, there is a growth of the common red clover (*Trifolium repens*), which yields a heavy cut of hay; but this plant dislikes the drought of other parts of the State. Nearly everywhere, on the moister or irrigated lands, very heavy crops of roots and marrowfat squashes are grown in the summer for late fall and winter feeding, and the climate is such that these products need no storage, but are fed right from the field whenever they are needed.

SUCCULENT FOOD DURING THE SUMMER DROUGHT.

It has been shown above that in our best years very little winter feeding is necessary, and even then only for a short period. The time when extra feeding is most desirable to maintain the flow of milk is in the late summer and fall. Some dairymen plan to have this their closed season, and with the cows coming in fresh in the fall, about the time when the new grass should put in its appearance, they practice winter dairying with fresh pasturage, which would seem to be a very natural arrangement for this climate. But even with this arrangement, or without it, it is exceedingly desirable to maintain the flow as late into the summer or fall as it can be profitably done. This is the season of "dry feed," previously mentioned, and even if such feed be abundant and rich, as described already, its lack of succulence checks the milk flow, and it gives the product something of the character of the Eastern winter butter. It is to maintain the character of grass products, as well as to increase the quantity of them, that much effort is made in those sections where the pastures dry up early. Available moist land is made to grow fodder corn or sorghum, which does vastly better in the hot, dry air of the interior than roots and squashes and other crops which furnish succulence in a time of drought. It is for this part of the year, and not for winter, that the silo is now being used by some dairymen, both North and South, and it is probable that it will be used more generally in the future than it has been in the past. To preserve for autumn the succulence of spring growth seems to be its chief function in California. At this time of the year, too, there is now becoming available considerable quantities of pulp from the sugar-beet factories, and this is also being siloed for winter use when necessary.

THE BEST DROUGHT-RESISTING FORAGE PLANTS.

For the improvement of California pastures it has long been seen that drought-resisting grasses and forage plants are very desirable. The great mass of the natural growth, and the chief of the introduced plants which found their way in at some remote period, are annuals. As soon as overstocking reaches the prevention of self-seeding, the pastures decline. For years the cry has been for perennial plants which would hold life in the root, and continual effort has been made in this direction by the California Experiment Station and by enterprising individuals. Our greatest acquisition has unquestionably been alfalfa, but alfalfa does not endure hard, dry soil; it requires depth and permeability and moisture within reach of its roots, and heat greater than some of our coast regions afford, to do its best. Of all the introductions of the last quarter of a century the best can be quickly named. They are perennial rye grass, especially from seed which comes to us after acclimation in Australia, and is locally known as "Australian rye grass;" orchard grass; meadow soft grass (*Holcus lanatus*), locally called "mesquite;" Texas blue grass (*Poa arachnifera*); tall oat grass (*Arrhenatherum avenaceum*); Schrader's brome grass (*Bromus unioloides*), and Hungarian brome grass (*Bromus inermis*). These grasses make a good winter growth, and being once well-established maintain life in the root through the dry season, not only furnishing moderately succulent forage during the dry season, but starting into active growth with the first fall rains. They will not do this in our very driest lands, but they will hold on in regions fit for dairying. They are coarse grasses compared with the choice summer grasses of humid regions, but, under the circumstances, they serve a very good purpose.

It is the spontaneous growth during our rainy season which should be compared with the summer growth of humid regions. This growth includes a large number of native species of grasses and clovers, different groups of species prevailing in the different parts of the State. Two foreign plants introduced in remote times also notably contribute to our winter pasture. They are the bur clover (*Medicago denticulata*), already mentioned, and alfilerilla (*Erodium cicutarium*). They cover the ground with a mat of the most tender herbage after the earliest fall rains, and respond with freedom of growth proportionate to the abundance of the winter rains, often yielding a good cut of hay in some parts of the State.

WINTER SHELTER IN CALIFORNIA.

Some hints of the winter care of our dairy stock have already been given in connection with the discussion of pasture. It should, however, be plainly stated that our winter or rainy season climate is so mild that it is possible to conduct a dairy without any shelter whatever for the cattle, and probably three-fourths of our cows have none. They pass the days and nights on the pasture ranges and are gathered into paddocks or "corrals" twice a day for milking. While it is possible to do this it is clearly not desirable, and though it saves the cost of sheds or barns, it is evident from the experience of those who follow a better system that the increased yield and better quality of product from cows which have shelter, when shelter is desirable, more than pay good interest upon the investment required to provide buildings. Cows which are compelled to stand through chilly and sometimes protracted storms can not do their full duty at the pail. Food has to go to maintain living temperatures in the body during such stress of weather.

Although our winter temperature, in all except the mountain region, rarely falls below freezing, the drenching of cold rains is still a severe tax upon animal endurance. Besides, milking in the open air during such storms is bad for the cows, bad for the milkers, and especially bad for the milk. Milking in the rain carries much of the hide-wash into the pail, and where the corral is floored with soft mud and manure so that the udder is befouled, it is next to impossible to get clean milk. California dairying is often condemned for such practice, and it should be, but in current comment the occurrence of the evil is often exaggerated. The contamination of the milk by corral dust in the summer is also a constant danger. It requires the greatest effort to avoid filth in open-air dairying. To accomplish this and for the benefit of the cows, and the comfort of the milkers, there has been a notable increase during the last few years in the number of barns and sheds on our dairy farms, and some adopt the practice of always milking under cover and of retaining the cows in the stanchions during heavy storms, and at least one establishment, that of D. D. Wilder, of Santa Cruz, not only has fine cow barns, but lights them and the adjacent corrals with electric lights. The conclusions of the most thoughtful dairymen on this subject are outlined well by Mr. James Boyce, manager of the Diamond Springs Creamery, Humboldt County, in these words:

> Cows are stabled at night about thirty-five to forty nights in the year and fed hay and roots. In some localities no barns are used; cows are milked in open corrals, and only get the grass that grows. But cows do better when sheltered from the rain and fed in warm barns during the rainy season of each year.

The importance of this matter is of course greater in regions of heavy and protracted rain storms and tenacious soils. In parts of the State where there is a light rainfall and sandy soils, the open-air system is less objectionable, but even in such places there are those who believe in good buildings and generous feeding in addition to pasturage. In the mountain region good dairy barns and ample winter food are provided as the wintry conditions require them.

WATERING DAIRY STOCK.

The water supply has been suggested in the foregoing descriptions of the dairy regions. Wherever perennial flowing streams exist they are fully drawn upon. Over a much greater area of the State, however, dependence is placed upon wells and windmills or upon flowing artesian wells, and in some cases upon water from irrigation ditches. This water is always of moderate temperature and no special methods of watering stock are employed.

MONTHS OF GREATEST PRODUCTION AND THE YIELD PER COW.

The months of greatest milk production in the southern half of the State, and in the interior, both north and south, are April and May. In the coast region north of San Francisco, owing to the later season of green grass, the two best months are May and June. But all the months from March to July, inclusive, give a good milk yield, and by due effort for feed and seasonable calving the dairy is run at considerable capacity the whole year. Except in the mountain region, many creameries are operated the whole twelve months.

The estimates of a satisfactory yearly product for an average cow, furnished by a large number of dairymen, vary widely. One correspondent places it as low as 150 pounds of butter and several cite 300 pounds. From 200 to 250 pounds of butter in a year is the range mentioned by most correspondents. Though there are bands of 30 to 80 cows reported from Humboldt County as ranging from 275 to 325 pounds of butter yearly, it is plain that such dairies are above the average, both in breeding and selection, or in feeding, or in both.

NUMBER OF CREAMERIES IN CALIFORNIA.

It is exceedingly difficult to state exactly the number of the manufacturing establishments which should be called creameries or butter factories in distinction from private dairies. This is due to the system of large dairy proprietorship in this State to which allusion has already been made. If we should call that alone a creamery which handles the milk of several producers, we should give creamery honors to some establishments which are smaller in cost and in production and less thoroughly equipped than other establishments which handle the milk of a single owner or renter of cows. As a matter of fact, the term "creamery" has often come, in this State at least, to signify any concern, however owned or managed, which is equipped with power, centrifugal separators, and the other concomitants of modern dairy practice.

As prices for dairy produce have declined to a level very near the actual cost of production, even by means of the best appliances and the most economical processes, there has been during the last few years a very general disposition to follow creamery practices as the only means of survival. The result has been a remodeling of the large private dairies as well as the organization of cooperative creameries. The largest and most successful creameries are situated in the coast regions both north and south of San Francisco. Occasionally one of these has proved illy placed or badly planned and defectively furnished, for dishonest and slipshod work in dairy building and equipment have been experienced here as elsewhere. We have also suffered to some extent from the nefarious efforts of the creamery "boomer," or promoter, and creameries have been constructed where there are no cows. Of these the buildings have been put to other uses and the machinery set aside or sold at a sacrifice.

By the closest computation that can be made, the number of establishments which are operating upon the creamery plan in California in 1896 is 300. Of these, 100 are creameries, receiving the milk from a number of patrons, and 200 are private dairies with power separators and other creamery adjuncts. These "private creameries" average about 150 cows each, with some of them having as high as 400 cows. The cooperative creameries range in cows from 250 to 4,000, with an average of 500 cows. Of these establishments about one-half are proprietary and the other half about equally divided between joint-stock and cooperative. All sorts of opinions are given by correspondents as to the comparative advantages of the different kinds of ownership. The joint-stock plan, if most of the stock is owned by the farmers of the neighborhood, seems to be most generally approved.

WIDE USE OF CENTRIFUGAL SEPARATORS.

All the creameries of California are conducted upon the separator plan. As previously stated in connection with the description of the dairy regions, the absence of natural ice and cool water in all save the mountain region renders all deep-setting devices impracticable, though refrigerating machines are being introduced for creamery use. The only issue then is that between the separator and the shallow pan, and the separator is the sine qua non in our creameries and is rapidly pushing out the pans in the smaller dairies as well. All the prominent patterns of separators are in use. The largest creamery in California is the establishment of the Guadalupe Creamery Company (cooperative), located at Guadalupe, on the coast, in the northwest corner of Santa Barbara County. It has capacity for the milk of nearly 4,000 cows, and is in a region of very large dairy holdings. It has one skimming station and uses altogether six separators, mostly of the Alpha De Laval pattern, and has received at times 60,000 pounds of milk per day. A very good representative report is that furnished by the Diamond Springs, at Swauger, in Humboldt County. In 1895 it received milk every day in the year, recording a total of 5,523,000 pounds of milk, from which there were made 263,000 pounds of butter; and 500 hogs, of from 100 to 200 pounds weight each, were grown upon the skim milk. This creamery paid out to 41 patrons the sum of $50,000 during the year. The largest amount of milk received in a single day was 40,000 pounds. This milk was handled with four separators. Other reports are as follows: Union Creamery, San Luis Obispo County, 20,000 pounds per day, two Alpha De Laval separators; in Eel River Valley, Humboldt County, five creameries of about equal size use four separators each, mostly Alpha De Laval; Scott Valley Creamery, Siskiyou County, 12,000 pounds, two Sharples separators; San Bernardino Creamery Association, 10,000 pounds per day, one Jumbo; Norwalk, Los Angeles County, 16,000 pounds, Alpha De Laval; Westminster Butter and Cheese Company, Orange County, 10,000 pounds per day (including two skimming stations), one Jumbo at creamery and one Alpha De Laval at each skimming station.

The Babcock test is almost universally adopted as a basis for payment for milk.

LENGTH OF SEASON AND SUNDAY WORK.

As already stated, almost all of the creameries in the coast regions run continuously throughout the year. A few stop during January and February. As for Sunday labor, there is some variation in practice, though the rule in the larger establishments is to operate on Sundays just the same as on other days. At San Bernardino only separation is done. This gives the patrons the skim milk for feeding and saves the housewives the care of the milk at home. In some other establishments no extra cleaning is done on Sunday, which somewhat shortens the day for the workmen.

MILK VALUES IN DIFFERENT MONTHS.

The returns made to patrons for milk, and the months during which high and low values rule, can best be shown by reference to reports received from widely distant parts of the State:

The San Bernardino Creamery Association reports returns per 100 pounds of milk during 1895, as follows: January, $1.10; February, $1.05; March, 90 cents; April, 75 cents; May, 70 cents; June, 65 cents; July, 80 cents; August, 90 cents; September, $1; October, $1; November, $1; December, $1.05.

W. W. Cocke, proprietor of the Star Cheese Factory, Downey, Los Angeles County, paid for milk, on a basis of 4 per cent butter fat, as follows: January, $1.15; February, $1.15; March, 74 cents; April, 74 cents; May, 78 cents; June, 87 cents; July, 87 cents; August, 95 cents; September, $1; October, $1.02; November, $1.10; December, $1.15.

P. A. Raab, proprietor of Bolsa Creamery, Orange County, reports payments per 100 pounds of milk as follows: January, $1.10; February, 90 cents; March, 65 cents; April, 50 cents; May, 57 cents; June, 65 cents; July, 80 cents; August, 89 cents; September and October, not running; November, $1.10; December, $1.20.

The following are returns in cents per pound of butter fat for three creameries in Humboldt County in 1895:

1895.	Diamond Springs.	Excelsior.	Riverside.	1895.	Diamond Springs.	Excelsior.	Riverside.
January	22	....	....	July	14½	15	15
February	17	....	....	August	23¼	21⅜	23
March	14	13	14	September	20¼	19⅛	21
April	12	12	12	October	23¼	23¼	23½
May	11½	11	11	November	31	31	31
June	14	13⅜	13	December	26½	25	26½

Grizzly Bluffs Creamery, Humboldt County, reports the average value of butter fat for the year 1895 at 18.69 cents per pound. At the Star Creamery in Sacramento County, which is in the alfalfa pasturage region, the total milk received during the year 1895 was 2,684,240 pounds, which yielded butter at the average rate of 4.34 pounds to the 100 pounds of milk, and returned to patrons a net amount of

$17,084.97, or 63¾ cents per 100 pounds of milk. The average price of butter was 18¾ cents per pound, the average freight and commissions a little less than 1 cent per pound, and the factory charge 4 cents per pound. This creamery had the advantage of a local market in the State capital, which is adjacent to the establishment.

PROPORTION OF CREAMERY PATRONS.

The creameries have usually succeeded in securing the patronage of nearly all the dairy farmers except in localities where the large-holding dairy system has brought creamery outfits into individual establishments, as already considered. An instance of this is in the Bodega district of Sonoma County, where but one-third of the dairymen patronize the creamery. In contrast to this state of affairs, in the leading valleys of Humboldt County more than nine-tenths of the dairymen carry milk to these establishments, while in the county as a whole more than one-half take this course.

DISTANCE OF MILK CARRIAGE.

The distance covered in carrying milk from the farm to the creamery is reported from Knights Landing, in Yolo County, where the distance is placed at 10 miles. As it is a region of riverside farms, it is contemplated to convey milk by a small steamer on the Sacramento River even from greater distances. The longest distances reported by inland creameries are 8 miles in Siskiyou County, 7 miles in San Luis Obispo and Mendocino counties, and 6 miles in Tulare and San Bernardino counties. Usually the longest hauls reported are 5 miles and the average from 1½ to 2½ miles.

FARM DAIRIES IN CALIFORNIA.

The farm dairy, as it is understood at the East, is very rare in California. What has been said of the beginnings of dairy work in this State shows that it did not spring from the farm house. Except at a few points in the early mining regions, where families drove their cows across the plains to the great dairy ranches on the coast, the dairy was man's work from milking to manufacturing. In early times in California women were too rare and precious to send into cow corrals or churn sheds. Profits were large enough to allow the dairy owner to hire all the men he needed, even at the high wages then current, and, besides, petticoats were things of which the cows of that day were in terror. As man was leader, the enterprise had to be large—for the Californian of that day had a horror of pothering with anything small—and rather than be in bondage to the family cow he would buy his butter and go without milk. While this condition has always prevailed in this State, and while on many ranches there were scores of horses and not a single cow, there has always been some farm-house dairying, and with the increase of thrifty farmers milk and butter for family use are now generally provided, except in settlements of small fruit farmers whose land and time are too valuable for dairy production.

Of the methods prevailing in the California style of private dairies before the introduction of centrifugal separators it is not necessary to speak at length, because they are quickly passing away. The small pan setting of milk was universal until the introduction of hand separators, because the absence of ice and cool water, except in the mountains, made all deep-setting contrivances impracticable. Various designs for cooling by evaporating water from sacking or other fibrous material surrounding the milk receptacles were proposed, but never widely used, except in keeping cream taken from shallow pans to await churning. Dairy rooms with walls of porous terra-cotta plates, through which water might ooze from an outside source and evaporate from the inner surface, have been projected, but never existed except on the original drawings. Tight double-walled and double-roofed milk houses, closed during the day and opened at night, when the air is always relatively cool in California, are the sum of the cooling arrangements employed except in some of the more generously equipped concerns where small freezing-machine outfits have been introduced.

The frequency of churning in these private dairies depends upon the size of the herd. As someone of alleged skill is employed as butter maker, it is aimed to have milk enough to churn every day; but in the smaller concerns churning is done at different intervals, even once in four days, which is the longest time mentioned by any of our correspondents. In the dry air of California milk keeps in good condition, even though no low temperature can be secured. Dairy butter is almost entirely put into rolls and sold at once. If packed either by the producer or by the city receiver in a time of surplus receipts, the rolls are put down in casks in their original form, packing the rolls as closely as possible without spoiling their shape, and filling the cask with brine. This is known locally as "pickled roll," and it is usually sold, just as it comes from the brine, several months afterwards, though sometimes a sort of renovating process is practiced by freshening and wrapping the rolls in new cloth, but this revived "fresh roll" seldom deceives anybody. More recently the use of cold storage in San Francisco has reduced the amount of pickling. The ruling amount of salt used in California butter, both creamery and dairy, is 1 pound of salt to 20 pounds of butter, although individual makers report 1 pound to 16. There is a little difference in the amount used in summer and winter, say at the rate of one-eighth of an ounce to the pound more in summer than in winter.

The creamery and farm-dairy butters are sold in the same markets, and the product by the modern method has quite an appreciable advantage in price. This is proving a potent factor in the transformation and reequipment of ranch dairies, as well as inducing the establishment of cooperative creameries.

THE CALIFORNIA BUTTER ROLL.

The almost universal form given to the California butter product, both from creameries and private dairies, is the 2-pound "roll" or "square." The first is a cylinder, the second a parallelopipedon. The original form was the cylinder bearing the imprint of the maker on the upper end, and these were originally of 2 pounds weight and were packed in flat boxes with hinged covers, holding 60 rolls. The depth of the box is a little more than the height of the roll, a cloth being placed over the ends of the rolls when the box is closed. Each roll is wrapped in muslin or butter parchment paper. As purchasers bought the butter at so much a roll, there crept into the trade very early a practice of slightly reducing the weight of the roll, so that the retailer who bought the butter by the weight of the box would have more rolls to sell by the roll. The first retailer who conceived this bright idea was thus enabled to undersell his competitors on the price per roll, and the reduction of the weight was at first so slight as not to attract attention. But the departure from full weight set a vicious example, which was soon followed and exceeded until the "2-pound" roll weighed only 1¾ pounds. Retailers would not buy full-weight rolls because they could not meet the ruling prices for a roll, and the producers were obliged to reduce the contents of their butter molds or lose in the price they could get per pound. This little matter of the size of a roll has been a constant subject of discussion for the last twenty years. Finally, in 1893, the State legislature passed a law entitled an act to prevent the sale of short-weight rolls of butter: "Any person or persons, firm or corporation, who offers for sale roll butter not of full weight to each roll, shall be guilty of a misdemeanor." But the act does not define a legal roll. No effort has been made to enforce this law, but there has been a growing sentiment in favor of full-weight rolls. The California Dairy Association has resolved in favor of them, and many creameries resolutely make them, but it is probable that it will be some time before the "short roll" will wholly pass from view.

Since the introduction of creamery practice some butter has been marketed in tubs, but probably not more than one-tenth of the creamery product takes that form.

CALIFORNIA FORMS OF CHEESE.

The local form of cheese which was early adopted in California because of its portability and ease of cutting was what is known as a "flat." The flat has about the same diameter and half the height of the ordinary Eastern factory size, and weighs from 25 to 30 pounds. It had originally the local peculiarity of having the color in the bandage instead of in the cheese—a white cheese in an orange-red bandage. This style still prevails, but "Young America" and Eastern factory styles are now followed to some extent, and the use of color in the curd instead of in the covering is now the rule even when the old form is followed. There has been some disposition to introduce the Eastern style of cheese box, but as the boxing has to be brought in the shook from the East, the use has been limited. Almost all the common forms of cheese originally come to the market "naked" or in packages of three cheeses in a burlap grain sack, and they are delivered by the receivers to the jobbers' or retailers' wagons in San Francisco without covering. When shipped to distant consuming points, two or three cheeses are cased in a square box made so as to fit closely and the cost of casing charged up to the cheese producer. This burden he has always protested against, especially as the charge for casing has been thought to yield the commission man something more than the service actually cost him. More recently a well-made box or case has come into use. It carries several flat cheeses and is returned to the factory by transportation companies without charge when empty.

Almost all the cheese made in California (except that made occasionally in creameries during low butter prices) is the product of proprietary concerns, and probably nine-tenths of it is from milk produced by cows owned or leased by the maker. The product is therefore almost wholly farm or ranch cheese, but the reader will understand that many of these farms produce as much milk as is received by the smaller Eastern "factories" and manufacture it in as enlightened a manner. Farm dairy cheese, as the term is used in the East, is hardly known in California. In country stores, however, there are always adequate supplies of California dairy or factory cheese, and it is retailed at all prices from 9 to 20 cents per pound, according to quality or distance from producing points. The average price for California cheese at retail is 12½ cents per pound.

Of the cheese branch of California dairying it may be said that it has never been developed as the natural adaptations of the State suggest. The prejudice for Eastern cheese, which has already been mentioned, is a serious obstacle and prevents the local producer from securing even the best of the local trade, which through limited population is necessarily small. There is at present no distant market which invites supply. The lack of inducement is perhaps to be cited as the reason why the local cheese interest has never developed commensurately with the butter interest. And yet California conditions favor the cheese maker in a notable degree. The dry air rules out that condition of "mugginess" which gives the Eastern factory man so much milk which calls for the use of high acid in the curd. The milk, in all save the hot interior at least, is clean and good. Some makers declare that in an experience of years they have never seen a "floating curd," and one maker reports from Humboldt County that it is the "easiest place to make cheese" he ever saw. This is common observation, and the fact that the sweet-curd process is widely employed is also very significant.

DAIRY MARKETS OF CALIFORNIA.

San Francisco, with thrice the population and more than thrice the local and distributing trade of any other California city, has always been naturally the great dairy market of the State. There is in fact only one other city which approaches even to one-third of the dimensions of San Francisco; that is Los Angeles, and she has only recently arrived at this estate. The growth of Los Angeles, and southern California generally, has, however, recently created a diversion of a part of the dairy trade southward, for the consumption of dairy goods in southern California is still considerably greater than the increased local production. Speaking generally, the surplus dairy production of the northern two-thirds of California goes to San Francisco and of the southern one-third to Los Angeles. Along the borders of this division shipments go either way, as the demand seems to warrant; but aside from this general movement, San Francisco reships large quantities to southern California, and sometimes the product of Nevada creameries goes direct to Los Angeles as a better market than San Francisco.

The receipts of butter and cheese in San Francisco during the year 1895, as compiled by the Journal of Commerce, were as follows:

	Pounds.
Butter:	
California manufacture	13,796,000
Oregon	413,000
Eastern	184,500
Total	14,393,500
Cheese:	
California manufacture	4,624,500
Oregon	132,400
Eastern	1,738,270
Total	6,495,170

The extension of the creamery interest in California has taken from San Francisco somewhat of its importance as a distributing market to the towns of the State, because creamery managers have developed direct trade with jobbers and retailers in the smaller towns as far as possible. Formerly there were large supplies sent from San Francisco to Portland and the Puget Sound cities. Recently the dairy development of Oregon and Washington, and the enterprise of the creamery interests of the region northwest of Chicago to ship their surplus westward by the Northern Pacific, have very much reduced California's sales in the northern regions of our coast. These regions are, in fact, so well fitted for dairy production that they will probably soon have a considerable surplus, for which they must seek distant markets.

San Francisco enjoys the distinction of being the third port of the United States in the export of dairy produce, New York and Boston alone exporting larger amounts; but this distinction is secured upon a very small volume of trade. The total valuation of the butter and cheese exports from San Francisco in 1894 was $118,530, and in 1895, $99,075. Of these amounts nearly one-half went to British Columbia, and for this trade in the future California must contend with the development of local production in the Dominion and compete with the coming surplus in the nearer States of Oregon and Washington, already alluded to. The other half of San Francisco's exports of dairy goods is distributed all over the countries bordering on the Pacific, including the Hawaiian Islands, the Asiatic countries, the islands of Oceanica, Mexico, and Central America—a magnificent geographical area, but one in which dairy demand is confined almost entirely to the small colonies of Europeans located at points of commercial importance. Californians have indulged in some speculations as to the possibility of developing dairy trade in these densely populated parts of the world, especially in Japan, and the same intention has been disclosed by the shippers of creamery products from the region northwest of Chicago, but there is much doubt whether these Asiatic people will change from their long established food supplies much faster than they will learn to produce for themselves. Shipments of dairy cattle have been frequently made from California to Japan during the last ten years, and their acquisition of dairy arts may be expected.

EASTWARD SHIPMENT OF CALIFORNIA BUTTER.

Some moderately encouraging results have been attained in shipping fresh California butter to the regions east of the Rocky Mountains during the closed season of Eastern dairies, but the growth of winter dairying at the East, the improvements in cold storage, and the improvement of Eastern winter-made butter by the use of succulent silage in connection with the old style of wintering on dry feed, coupled with the vast superiority of the keeping quality of creamery butter over the old firkin product, tends to reduce the field which California fresh winter butter might have enjoyed if the Eastern product had not thus improved. Still it is hoped that by developing the creamery system here, and thus rendering available large uniform lots of butter for Eastern shipments before the Eastern grass butter comes forward, California may find some outlet eastward at favoring times of the year for an amount at least equal to the shipments from the East to California during the months when our output is small. Either this must come or some very notable increase of local population, by the development of mining interests which are now very promising or by other local industrial advancement, is necessary, before any great increase of the present dairy production of California will be warranted. In fact, in the upper San Joaquin Valley, with no large towns and a long haul by rail through a hot valley to reach either San Francisco or Los Angeles, two cheese factories did not open in 1896 because of oversupply in local markets. But while this is the case, there is still a steady consumption of Eastern and foreign cheese in preference to California cheese. For the last five years this supply has averaged about 1,750,000 pounds annually, and this continues, although California producers have made some effort to give their product the form and character of the popular Eastern and European cheeses. There is a prejudice among certain classes of consumers for "imported" goods which handicaps local producers in their efforts to produce similar articles. This is in part inexplicable, and in part due to the inheritance of a bad name from our earlier years of careless dairying.

DAIRY ORGANIZATION AND PROTECTION.

The first State Association of California Dairymen was organized in 1876. It was modeled after the leading associations east of the Rocky Mountains. Several interesting conventions were held in San Francisco, but the dairy public did not manifest the interest which was expected and the effort was abandoned. In 1882 the industry was menaced by a proposition to establish an oleomargarine concern in San Francisco, and this provocation rallied the legitimate producers in a large convention held in December of that year. A draft of an enactment against imitation dairy goods was agreed upon and it was passed by the California legislature in the winter of 1883. It was a good law, but it offered no reward for information and the dairymen relaxed their cooperative efforts as soon as the law was safely inscribed upon the statute book. There was then no machinery to promote prosecution, and the only effect of the law was to prevent local investment in oleomargarine enterprises. Year after year, however, imitation products were brought in from the East and freely sold in defiance of the law without prosecution. Just as soon as prices showed a tendency to advance with the lessened dairy production of the autumn, great quantities of the spurious goods were shipped overland to California, to the great distress of producers of the pure article. The passage of the United States law led to delay in the hope that it would check the evil. At last, in 1893, it was evident to dairymen that they must do something more effective than they had yet accomplished in their own behalf, and a new association, called the California Dairy Association, was organized in the fall of that year, which has constantly increased in membership and has full promise of permanence. It held excellent conventions in San Francisco in 1894 and 1895, and during the present year has held monthly meetings at different dairy centers in addition to its annual convention. But the chief achievement of the association, supported by the dairy interest at large, was done at the session of the California legislature of 1895 in the enactment of a new dairy protective law and the creation of a State dairy commission to enforce its provisions. The law providing for these two results was approved March 9, 1895, and is condensed as follows:

The coloring of oleomargarine or other imitation product in imitation of butter or cheese made from unadulterated milk is absolutely prohibited. And the possession of, sale of, or offering to a patron for consumption, such imitation product when colored to imitate the genuine, is a misdemeanor.

The use of the words "butterine," "dairy," "creamery," or of dairy symbols in connection with the sale or advertisement of the imitation product is absolutely prohibited.

In the handling of the imitation product, the manufacturers, shippers, carriers, wholesalers and retailers, peddlers, bakers, hotel, restaurant, and boarding-house keepers must comply with certain regulations as to the labeling of the packages, the specification by printed statement of the contents and the proper notification of the purchaser, consumer, or patron.

Other provisions of the law invalidate a contract made in violation of the act, prohibit the use of imitation products in charitable institutions; make the effacement of labels and marks a misdemeanor; provide what is evidence of intention to violate the act; authorize the State Dairy Bureau to make use of the search warrant; require the district attorney to prosecute and the informer to receive half of the fines; and establish a State Dairy Bureau for the period of two years and with a fund of $12,000 for the enforcement of the act. Violation of any of the provisions of the act is a misdemeanor, and a first offense is punishable by a fine of not less than $50 nor more than $150 or by imprisonment for not more than thirty days; and subsequent offenses are punishable by a fine of not less than $150 nor more than $300 or by imprisonment for from thirty days to six months, or by both.

In compliance with the terms of this law, Messrs. L. Tomasini, Thomas Flint, sr., and George W. Burbank were appointed to constitute the State Dairy Bureau, which began on May 1, 1895, a vigorous prosecution of the law. This action resulted in the abandonment of a projected local manufactory of oleomargarine, and vigilance on the part of the bureau has reduced the trade in imitation products made elsewhere to a very small aggregate. This result, coupled with the low price of butter, has practically freed California, for the time being, at least, from competition with imitation products which had been for years very grievous. The secretary and executive officer of the bureau is William Vanderbilt, and the offices are at 113 Davis street, San Francisco.

In addition to the foregoing official organization for dairy promotion and protection, are the following voluntary associations for the purposes specified:

California Dairy Association.—Incorporated September 2, 1893, for educational and legislative objects. Directors: Joseph Mailliard, president, San Geronimo; A. P. Martin, first vice-president, Petaluma; William N. Russ, second vice-president, Eureka; John A. Cole, third vice-president, San Bernardino; F. H. Green, treasurer, San Francisco; Samuel E. Watson, secretary, San Francisco; W. W. Wynn, Livermore; William Niles, Los Angeles; R. H. Brown, Pescadero; H. M. Le Baron, Valley Ford; P. Tognazzini, Cayucos. Meets monthly at different points and holds annual convention. Reports sent on application to secretary, 113 Davis street, San Francisco.

Dairymen's Union of California.—Incorporated August 17, 1891, with capital stock of $250,000, subscribed by dairymen, to carry on a general commission and produce business. Directors: Warren Dutton, president; G. W. Burbank, vice-president; E. W. Steele, treasurer; J. R. Denman, secretary; L. Tomasini, manager; Samuel Donati, F. Madonna, P. Tognazzini, A. Tognazzini, M. Righetti, S. Cheda. Location of business, 113–119 Davis street, San Francisco.

Dairymen's Association of Southern California.—Organized in July, 1894, for educational and legislative purposes. Directors: D. Durkee, Rincon; C. E. Mitchell, Clearwater; W. H. Smith, Norwalk; P. F. Cogswell, El Monte, and G. E. Platt, Los Angeles. Officers: C. H. Sessions, president, Los Angeles; George H. Peck, vice-president, El Monte; R. R. Risdon, secretary, Los Angeles. Meets quarterly, on the second Saturday of January, April, July, and October.

BULLETIN NO. 15. (Dairy No. 6.)

U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF ANIMAL INDUSTRY.

THE CHEESE INDUSTRY

OF

THE STATE OF NEW YORK.

BY

B. D. GILBERT,

Special Expert Agent, Dairy Division.

Under the direction of

Dr. D. E. SALMON,

Chief of the Bureau of Animal Industry.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1896.

BULLETIN No. 15. (Dairy No. 6.).

U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF ANIMAL INDUSTRY.

THE CHEESE INDUSTRY

OF

THE STATE OF NEW YORK.

BY

B. D. GILBERT,

Special Expert Agent, Dairy Division.

Under the direction of

Dr. D. E. SALMON,

Chief of the Bureau of Animal Industry.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1896.

LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY,
Washington, D. C., October 17, 1896.

SIR: I have the honor to transmit herewith a report upon the Cheese Industry of the State of New York, prepared under the supervision of Henry E. Alvord, chief of the Dairy Division, by Benjamin D. Gilbert, special expert agent of that division. Mr. Gilbert is secretary of the New York State Dairymen's Association, and has been for years secretary of the Utica Board of Trade and dairy editor of the Utica Herald. The report includes a chapter describing in detail the most approved method of making full-cream factory cheese, by G. Merry, also special agent of the Dairy Division.

It is respectfully recommended that the two reports be combined and published as a bulletin of this Bureau.

Very respectfully,
D. E. SALMON,
Chief Bureau of Animal Industry.

Hon. J. STERLING MORTON,
Secretary.

CONTENTS.

Page.
History of cheese making in New York State.......... 7
  Localities where first undertaken.......... 7
  Methods practiced in early times.......... 9
    Heating the milk.......... 9
    Rennets.......... 9
    Lack of apparatus.......... 10
    Measuring the milk.......... 10
    Marketing.......... 10
  Early cheese making in New England.......... 11
  Early cheese making in Pennsylvania.......... 12
Statistics of cheese production.......... 13
  Production of New York State compared with that of the whole United States.......... 13
  Farm dairy cheese.......... 15
  Production in New York in 1895.......... 16
Statistics of exports and imports of cheese.......... 19
  Exports of American cheese.......... 19
    Cause of increase.......... 20
    Causes of decrease.......... 21
  Imports of foreign cheese.......... 24
Fancy cheese.......... 26
  Different varieties made in the State of New York.......... 26
  Principal factories where made.......... 27
  Manufacture of Limburger, Sweitzer, Münster, etc.......... 32
    An expert opinion on the requisite dairy work.......... 33
Dairy boards of trade in the State of New York.......... 34
  Their history and purpose.......... 34
  Methods of sale and shipment.......... 35
Cheese factories in New York.......... 36
  Introduction, increase, and present number.......... 36
  Size of factories.......... 37
  System of management.......... 37
  From factory to table.......... 38
The future of the American cheese trade.......... 39
  Causes of discouragement.......... 39
    Canadian competition.......... 39
    Australasian competition.......... 40
    The lessened exports.......... 41
    Filled cheese.......... 41
    A new law in New York.......... 42
  Some grounds for encouragement.......... 42
Factory cheese and how it is made. By G. Merry.......... 45
  Modern methods practiced in the United States.......... 45
    Handling milk.......... 45
    Taking samples.......... 46

Factory cheese and how it is made—Continued. Page.
Modern methods practiced in the United States—Continued.
Heating milk 46
Determining ripeness 46
Handling the curd 47
Pressing and curing 49
Method of apportioning dividends upon the fat-test basis 50
Appendix 53
Tables of cheese production and traffic 53
Table I. New York receipts of butter and cheese 53
II. Transactions of the Utica Board of Trade 53
III. Transactions of the Little Falls Board of Trade 53
IV. Transactions of the Watertown Board of Trade 54
V. Production of cheese in New York State, by counties 54

THE CHEESE INDUSTRY OF THE STATE OF NEW YORK.

By B. D. GILBERT,
Secretary New York State Dairymen's Association.

HISTORY OF CHEESE MAKING IN NEW YORK STATE.

LOCALITIES WHERE FIRST UNDERTAKEN.

The art of cheese making in this country dates back a hundred years or more from the present time, but the science of cheese making, or its manufacture on scientific principles, is not 50 years old, and is far from being fully understood in this year of grace 1896. Thirty years ago Mr. X. A. Willard, who was then the chief expositor of our cheese industry in the public journals and pamphlet literature of the day, stated in an address before the American Dairymen's Association that he remembered to have seen the persons who first began cheese dairying in Herkimer County, N. Y., and to have eaten of the product of their manufacture. This would carry cheese making in Herkimer County back to the early part of this century; but the following statement indicates that this art was practiced at an earlier date in a county farther south. In a volume entitled Memoirs of the Board of Agriculture of the State of New York for the year 1826, there is a paper on "The manufacture of butter and cheese," by S. DeWitt, of Albany. In it he says:

> When I first came to Albany more than thirty years ago, I found a Mr. Hudson, an Englishman, settled as a farmer near Cherry Valley, celebrated for his excellent cheese; afterwards a Mr. Tunnicliff, also an Englishman, on the Susquehannah, equally celebrated in the same way. I have had cheese from both which would not suffer in comparison with the best from England of the same age.

This takes us back to 1795 or 1796, and locates cheese making at that time in what is now Otsego County. It gives the honor of beginning the art in the State of New York to native-born Englishmen, and shifts the scene from Herkimer County to Otsego County.

But while it is probably true that Herkimer was not the pioneer county in making cheese in this State, it is certainly true that she soon forged ahead of all other districts, and maintained her lead with great preeminence down to the introduction of the factory system in 1851. That cheese was made there early in this century is attested by a

Mr. Osborn, who spoke at a meeting of the State Agricultural Society in 1854. He related how Daniel Day came from Uxbridge, Mass., about the year 1808, and settled in the town of Newport, "a wild, woody region, and a hard country for new settlers." Here he purchased 200 acres of land and stocked it with ten or twelve cows and some sheep. The old man had formerly been connected with a manufacturing establishment "down East," and twice a year he would take off a load of wool, butter, and cheese and bring back a load of factory goods in exchange. In 1813 Mr. Osborn's father purchased the Day farm, and continued to carry on the same business. His description shows how crude were the methods in vogue:

> There was the cheese press, a simple bench 8 or 10 feet in length, with a frame at one end for the lever, and guides for this lever at the other end, and then another lever over these guides the other way to raise the weight on the end of the pry. The cost of this press was about $1. All the other utensils of the dairy were about after the same order. There was a constant strife between the cheese hoop and the churn as to which should have the lion's share of the cream. During the summer season when there was some risk in making butter, much of the cream went into the cheese, and as cold weather approached it was pretty evenly divided; but late in the fall cheese was sometimes made of the pure sky blue, the classical name of which was "white oak." Whether it acquired this name from the resemblance of its color to the wood or from its toughness is uncertain.

So it seems that the same tactics were practiced eighty years ago, in the infancy of the business, as are current now, and probably will be as long as cheese shall be made.

It is a curious fact that some of the earliest things published in this country on the subject of cheese making were descriptions of several varieties of cheese made on the Continent of Europe which have never yet been produced here with success. In the same memoirs of the State board of agriculture quoted above, but in the volume for 1823, there is a description of a Parmesan cheese dairy, together with directions for making Edam, Swiss, and Brie cheese, thus representing the make of four different countries on the Continent. By that time there must have been a considerable amount of cheese made after the English style in the interior of the State, for Mr. De Witt asked in 1826, "Why is it that while tons of this article (cheese) are brought to our market (Albany) it is so extremely difficult to find any which a man of taste would tolerate on his table?" The fact is that the Dutch of the Mohawk Valley, whose ancestors might have brought over some knowledge of making the kinds of cheese known in Holland, seem to have entirely lost the art. Mr. Aaron Petrie, of Little Falls, stated in a letter to the State Agricultural Society, in 1841, that "about 1820 the dairy business began to attract attention in the northern part of Herkimer County, particularly cheese making. All who adopted it flourished at once, and it is another instance of the difference of policy pursued by the descendants and settlers of New England and their Mohawk neighbors that the benefits of dairying were confined to the former for at least ten years, and indeed until the sterility of the once fertile land of the Mohawk compelled the latter to adopt it."

METHODS PRACTICED IN EARLY TIMES.

In those early days cheese was made in a more or less haphazard fashion and on a comparatively moderate scale, since it was all made in private dairies and principally by the women of the household. The amount of milk was necessarily limited, the dairies ranging from 10 or 12 to 35 or 40 cows, so that there was no difficulty in working it in large tubs.

Heating the milk.—There was difficulty, however, in applying heat, and this was one of the causes which rendered the product uneven in quality, although made by the most practiced hand. Various methods were used for this purpose. One writer gives the following description:

> Milk is put into a brass pan and made scalding hot by placing the pan on a furnace or in a vessel of hot water; then one-half of it is poured into the cheese tub among the cold milk and the rest into a pan in which the cream had been put. The cream and the hot milk being intimately incorporated, the whole is poured into the cheese tub, which by this time has received great addition, if not the whole of the morning's milk warm from the cows.

Another method is described as follows:

> A brass kettle nearly filled with water is then suspended in the vat, reaching within 4 inches of the bottom, into which is inserted a lead pipe attached to a patent steamer; the mass is then warmed to 85°, being stirred gently with the hand during the time of warming. The heat is then increased fast enough to bring the whole mass up to 100° F. in forty minutes.

The degree of heat was in many cases simply guessed at from contact of the hand with the milk. As late as 1842 a maker who took a prize at the State fair with his cheese, in describing his method of manufacture, said:

> The milk when ready for the rennet should be some degrees less than milk warm (*as I never have used a thermometer* I can not say *how* many).

The same man says that his cheese are pressed "by means of a weight on one end of a lever resting on the cheese follower as a fulcrum near the other end." This was the single-lever press. The double lever has already been described.

Rennets.—Another cause of poor cheese was the slovenly and inadequate preparation of the rennets. There is more literature on this subject in the publications of that period than on any other topic of the dairy. What kind of rennets to use, how to feed and when to slaughter the calf, how to clean and dry the rennets, what color a good rennet should have, how to preserve and keep it for the proper length of time, are all subjects that are discussed elaborately. As late as 1866, Mr. Weeks, the secretary of the American Dairymen's Association, stated that "a substitute for rennet that shall be cleanly and of uniform strength is what we most need in cheese making."

Lack of apparatus.—In those days there was no patent apparatus to lessen the work of the cheese maker. Success or failure depended wholly on the judgment of the individual, and that was formed by a long period of apprenticeship and by the experience gained through years of hard and faithful work. Women as a rule made the cheese; they did even more than that, they helped milk the cows in the open air, often out in the rain or snow, and they also took care of the milk. The fact that American cheese not only met with a large sale at home, but by the year 1847 was exported to the amount of 15,637,600 pounds, speaks well for the skill of our foremothers in manufacturing this product of the dairy.

Measuring the milk.—As late as 1842 the amount of milk used in cheese making was measured by gallons instead of pounds. For instance, one writer produces the statistics of his dairy, which show that in September 674 gallons of milk made 733 pounds of cheese. From October 1 to October 9, inclusive, 523 gallons made 643 pounds, while from October 10 to October 19, inclusive, 574 gallons made 683 pounds. This showed that it took less milk to make a pound of cheese as the season progressed, but it was impossible to establish a ratio. When the manufacture of cheese assumed larger proportions, especially after the introduction of the factory system, it was found very inconvenient to have one standard for measuring milk and another for measuring its product. Evidently the cheese and butter could not be measured by quarts and gallons, so in order to unify the standards it was determined to measure the milk by pounds. This was rendered absolutely necessary by the requirements for handling milk at the factories. If measured by the quart or gallon it would take the whole day to credit the different patrons with the amount of milk delivered by each. But the moment that milk began to be measured in pounds, the whole matter was simplified, and the ratio between milk and its products, butter and cheese, could be established without difficulty.

Marketing.—The manner in which cheese was put up for transportation should also be noticed. Originally the cheese had no protection or covering; they were laid carefully in the bottom of a wagon covered with straw, in order to carry them to market or to peddle them around the country. At this time, it should be noted, not even a bandage was put around the cheese. In the next improvement long, rough casks were made, in which from four to six cheeses were placed, one on top of the other, so that a number could be handled at a time without much injury to the cheese. In this shape cheese was sent to the New York market for many years, and it is still the manner in which Swiss cheese is shipped, both in this country and abroad. Finally, the plan of boxing each cheese separately was adopted, and about the same time our makers began to use bandages around the cheese. The first evidence of this which appears in the market reports is found in December, 1841. Previous to that time, the stock had been quoted as "Cheese Am."

(American). But that winter a new quotation appeared. Cheese "in bxs." was quoted at 7 @ 8c., while cheese "in casks" brought only 6 @ 7c. The modern idea that neatness in putting up any article of food is an element in the successful sale of that article found an immediate practical illustration in the sale of cheese. Probably the cheese put up in boxes was no better in quality than the cheese that was shipped in casks; but the more tidy appearance of the goods that were boxed, and the protection afforded by the boxes, caused them to sell for a cent a pound more than the old style as soon as they appeared in market.

About the year 1830 the production of cheese had become sufficiently large to engage the attention of special buyers. The product was not then sold as it is now, at twenty to forty days from the hoop. The whole season's production was kept until fall and then marketed in the bulk, just as butter used to be and still is, in some of the remoter districts. From 1810 to 1830, which was the introductory period of manufacture, the product was peddled around the country by the farmers themselves. One might imagine that cheese made and sold under these circumstances would not only not meet the requirements of our modern tastes, but would hardly be a palatable article of food for less critical and more uncultivated tastes. But it is a fact that the cheese makers of that early day throve remarkably well, so much so that their numbers increased rapidly; and this furnishes good evidence that their product was liked and appreciated by the public of that day, however much it might be criticised by a consumer of the present time.

As soon as the idea gained a foothold in the minds of traders that there was money to be made in handling this product of the dairy, they began to make a regular business of buying cheese. Starting out early in the fall, they carefully canvassed the entire region where this industry was carried on, contracting for the whole season's make of as many dairies as they could buy at figures which promised them a profit. Whatever stock was sent to tide water went by canal, and a moderate proportion of the cheese contracted for by buyers during the twenty years between 1820 and 1840 was sold to exporters.

EARLY CHEESE MAKING IN NEW ENGLAND.

How long ago cheese was made in New England it is not easy to discover. We know that in 1802, soon after the inauguration of Thomas Jefferson, a delegation went from the town of Cheshire, Mass., to Washington, D. C., taking with them, on a wagon drawn by six horses, a mammoth cheese for presentation to the President.[1] The committee also carried with them an address from the inhabitants of the town with the inscription, "The greatest cheese in America for the greatest man in America." As early as 1819, at the first exhibition of the Worcester, Mass., society, there was one premium given on cheese and it was awarded to Messrs. John and David Hunter, of North Braintree. This was the banner town in cheese making for many years afterwards. In the report of the society for 1852 it was stated that at all the exhibitions held there for thirty-three years a majority of the premiums on cheese had been bestowed on citizens of North Braintree. It was also stated that "our farmers had an opportunity of examining specimens of cheese from New York, and we may hope for similar favors from other States." In 1851 the report of the Hampshire society contained a flattering statement concerning New York dairymen. It said:

---

[1] It is a curious fact, in line with President Jefferson's big cheese, that in the early days of the factory system Mr. Willard spoke of large cheeses weighing 700 to 1,000 pounds as being frequently made, and as bringing 17 cents per pound when cheese of the ordinary size would sell for only 10 to 12 cents.

> May the day soon arrive when our dairies shall become to old Massachusetts all that the dairies of New York are to the Empire State. The average annual product in 1846 of the dairies of Herkimer County ranged from 500 to 650 pounds of cheese per cow. A Mr. Rottier, of Jefferson County, in 1849, produced from 26 cows an average of from 125 to 150 pounds of butter and from 300 to 400 pounds of cheese per cow. When the farmers of the Connecticut Valley *will* to have such products, with the blessing of God they will come.[1]

This shows that, as far back as the forties, New York State was leading the rest of the country in cheese making.

EARLY CHEESE MAKING IN PENNSYLVANIA.

In Pennsylvania also there was cheese made for family use at an early date. MacMaster, the historian of the people of the United States, informs us that in Lancaster and other towns in the neighborhood of Philadelphia many of the settlers were Germans who possessed great thrift and industry.

> With the exception of fresh meat, everything the German ate grew upon his own land. His food was chiefly pork and rye, onions and sauerkraut, milk and cheese, and turnips and Indian corn. The good wife and her daughters worked the loom, made the cheese and butter, and when the harvest came toiled with the sickle in the field.

This was in the year 1800.

---

[1] The figures, however, are exaggerated and misleading, as may be seen by analyzing them. For example, 150 pounds of butter in those days would require 3,750 pounds of milk, and 300 pounds of cheese would take 3,000 pounds of milk, making a total yield of 6,750 pounds of milk from each animal in a dairy of 26 cows. There are comparatively few dairies even now that will give such an average yield as that. As for the "annual average product" of Herkimer County dairies ranging from 500 to 650 pounds of cheese in 1850, such a statement is hardly to be credited. In the report of the New York State Agricultural Society for 1844, Mr. Alonzo L. Fish published an account of the management of his dairy farm in Herkimer County. He stated that in 1842 the average product of cheese from his dairy of 25 cows was 714 pounds, while in 1843 the average was 650 pounds, one-quarter of the animals being heifers. Possibly this was in the mind of the writer who gave the above-quoted estimate for Herkimer County.

STATISTICS OF CHEESE PRODUCTION.

The statistics of any business form the touchstone by which to judge of its prosperity or the reverse. There are no statistics of the cheese business in this country which can be relied upon previous to the United States census of 1840. It is stated in Transactions of New York State Agricultural Society for 1851 that "the first exports (of cheese) were in 1789, but they were very inconsiderable and were not of an extent to command even the attention of Congress till 1820." Prior to the last-named date the statistics of exports and imports were reported very imperfectly, while no attempt had been made to gather the statistics of production. By the act of Congress under which the census of 1820 was taken the name and nature of certain articles manufactured, their market value, and some other details were given; but cheese and butter were not included, and the figures were all so poorly collated and so unsatisfactory that in the census of 1830 no attempt was made to secure industrial statistics.

PRODUCTION OF NEW YORK STATE COMPARED WITH THAT OF THE WHOLE UNITED STATES.

In 1840 the value of dairy products of all kinds was taken together and without record of quantities; the value for the whole United States was $33,787,008, New York State producing $10,496,021 of this amount. When the State census was taken in 1845 it was estimated that one-third of the 999,400 cows employed in the dairy throughout the State were devoted to the manufacture of cheese, giving 36,744,976 pounds in all, or about 110 pounds per cow. This was probably not far from correct, although if there was an error it lay in the direction of underestimating. We have the actual figures giving the tons of cheese moved on all the State canals in 1846 and 1847. In the first-named year 15,417 tons of New York State cheese were transported, besides 3,616 tons from other States and Canada. In 1847 the New York State cheese carried amounted to 15,983 tons, along with 4,056 tons from other States and Canada. If we turn the long tons of State cheese into pounds, we find that in 1846 there were 34,534,080 pounds, and in 1847 there were 35,801,920 pounds, showing an increase of 1,267,840 pounds during the year. Undoubtedly there was a considerable amount of cheese sold at markets where it could be delivered by team, and this, added to the quantity transported by canal, would indicate that the census estimate for 1845 was pretty nearly correct, although probably somewhat smaller than the facts would warrant.

The national census of 1850 credited New York State with producing 49,741,413 pounds of cheese, but the State census of 1855 gave only 38,944,240 pounds, a decrease of 10,797,173 pounds. This would be difficult to explain if it stood alone, especially as the number of milch cows in 1850 was only 931,324, while in 1855 the number of cows had risen to 1,123,634, a difference of 192,310 in favor of the latter year. A partial explanation seems to be that there was a heavy increase in the production of butter, the price rendering it more profitable to convert the milk into butter than into cheese. The production of butter in 1850 was 79,766,094 pounds, while in 1855 it had increased to 90,293,073 pounds, an improvement of about 12½ per cent. If we convert the butter product of 1850 and that of 1855 into their equivalents in cheese and add to each the cheese product of those two years separately, it will be found that the total for 1855 exceeds the total for 1850 by only 15,500,000 pounds. Divide this by the excess in number of cows in 1855 and it gives a product of only 80 pounds of cheese per cow, or just one-half the estimated production of cheese per cow in 1850. The probability is that there was some error in the State census of 1855, inasmuch as the census of 1860 showed a production of 48,548,288 pounds, or within 1,200,000 pounds of the product in 1850. Presumably the production of cheese during the decade that extended from 1845 to 1855 was fairly even and steady, while that of butter was considerably increased, along with the increase in the number of cows.

Down to this time the introduction of the factory system seems to have made no great difference in the quantity of cheese made either in New York or in the whole United States. There was comparatively little change either in the absolute or the relative amounts. The figures are as follows:

Year.	United States.	New York.
	Pounds.	*Pounds.*
1850	105,535,893	49,741,413
1860	103,663 927	48,548,289

A decrease of 1,871,966 pounds for the whole country is less than the decrease of 1,193,124 pounds for the State alone; but both amounts are small and not especially significant where such large totals are concerned. When we reach the State census of 1865 we find that a long stride forward has been taken. The figures for that year were 72,195,337 pounds, showing an increase in the State of 23,647,048 pounds, or 48½ per cent. This was the result of the wonderful extension of the factory system. During the period from 1851 to 1860 this system was in an experimental stage. Even in 1861 Mr. Willard spoke of the system as having been but lately introduced, and said:

> A brief statement has been made as to this plan of cheese manufacture because it is comparatively new, and because it may possibly prove suggestive, not only to persons already engaged in dairying, but as offering a feasible plan for those unacquainted with the art in districts where it is proposed to introduce dairy farming.

And in 1871 Hiram Walker said:

> It is but nine years since the first cheese factory was erected in Oswego County.

It evidently took about twelve or thirteen years for dairymen to make up their minds whether or not the factory system was advantageous and was going to prove a success.

The next five years showed an increase of 28,580,675 pounds, bringing the total up to 100,776,012 pounds, an improvement of very nearly 40 per cent. This was under the national census, and we are therefore able to compare the yield of this State with that of the United States. It will make the matter somewhat clearer to put the figures in tabular form.

Year.	United States.	New York.
	Pounds.	*Pounds.*
1870	162,927,382	100,776,012
1860	103,663,927	48,548,289
Excess of 1870	59,263,455	52,227,723

This is a most remarkable statement, inasmuch as it shows that while New York had increased her production more than 52,000,000 pounds, or considerably over 100 per cent, during this decade, all the rest of the United States had only increased by the comparatively small amount of 7,035,732 pounds. Probably it will be said that the civil war prevented the extension of cheese manufacture in other States, but it is not easy to discern why the war should have had more effect in other Northern States than it did in New York. The more probable explanation seems to be that New York, being the State in which the factory system originated, appreciated more readily the importance of the system and was quick to take advantage of the enormous prices paid for cheese during the years 1863 to 1870.

The State census of 1875, the last one taken, again showed a small decrease of 2,050,840 pounds. This is only 2 per cent of the product of 1870, while the increase in the production of butter amounted to 3 per cent, thus showing where and how the milk had been used. The national census of 1880, however, gave an increase of cheese made in this State amounting to 30,438,542 pounds, or a little less than 31 per cent, and bringing the total up to 129,163,714 pounds, the highest total production of cheese ever reached in the State according to a United States census. That year New York made 56½ per cent of all the cheese produced in the United States. The figures for 1890 were not so favorable, being only 124,086,524 pounds, a shrinkage of 5,077,190 pounds, or 4 per cent, while the production of the whole country was 13,604,033 pounds greater than in 1880. There seems to be no doubt that the manufacture of cheese was then really on the wane in this State and that it has continued to decrease since that time.

FARM DAIRY CHEESE.

In the case of cheese made on dairy farms this reduction is especially noticeable. The census figures show this very plainly, as follows:

Farm dairy cheese made in the State of New York in—

	Pounds.
1875	7,778,413
1880	8,362,590
1890	4,324,028

There was an increase in this class of goods between 1875 and 1880 of nearly 6 per cent, but in the decade between 1880 and 1890 the shrinkage was almost 50 per cent. This is easily accounted for by the fact that many factories which ordinarily made large sizes found it to their advantage to change their style in the fall and manufacture small sizes, such as are usually made in private dairies. As a rule dealers prefer to handle factory-made cheese, especially when produced in a well-known establishment, where the stock is likely to prove more uniform in its character. This and the growing distaste of the women of the farm to continue the hard labor involved in cheese making have vastly diminished the amount of farm dairy goods and bid fair to nearly eliminate them from the market.

PRODUCTION IN NEW YORK IN 1895.

Inasmuch as no State census of New York was taken in 1895, it is impossible to give absolute figures for the cheese production of that year. An attempt has been made, however, to get at these statistics as accurately as was feasible without resorting to actual census methods. The transactions of the different boards of trade in the State for the season of 1895 have been obtained, as well as the purchases of many individual buyers in other parts of the country. From a number of the large combinations in the western part of the State also the statistics of their manufacture have been received, and in addition to these an estimate on the unreported and unknown sales to home buyers and to dealers in those parts of the State which have no public market, has been made upon principles which will be explained hereafter. In making up this estimate one great fact had to be steadily borne in mind. The drought of the summer of 1895 was the longest and most severe of any that has occurred in this State in a quarter of a century, which means since boards of trade were established in the interior of the country. In the central and northern parts of the State the shrinkage in the output of cheese was fully 20 per cent; in the western part it ranged from 25 to 33 per cent. Early in June the poor condition of grass began to show itself, and it was attributed to a combination of causes. Prominent among these were the long drought of the previous season, which killed the roots of the grass and seriously thinned the meadows, and the heavy frosts which occurred both early and late in the spring of 1895, the latest occurring the morning of May 22. From the middle of June to the middle of July there was no rain and the hay crop was fully one-quarter short. There were occasional showers after that, but cows kept right on shrinking in their milk yield, which was no larger the 1st of August than it usually is on the 1st of October. In the western part of the State the drought was so severe that in some instances boughs of trees were lopped off that cattle might feed on the leaves. Some dairymen were even prosecuted at law because they actually starved their cattle. They had nothing on the farm to feed to the cows, and could not or would not buy sufficient food to keep them from suffering.

In order to show upon what foundation the estimate of the production of 1895 is based, the figures obtained from different sources are here collated:

Boards and markets.	Number of boxes.
Utica Board of Trade	218.545
Little Falls Board of Trade	150.207
Watertown Board of Trade	98,845
St. Lawrence County Board of Trade	85 000
Fulton Board of Trade	49,656
Ogdensburg Board of Trade, about	32,000
Gouverneur Board of Trade	21 730
Marketed at Cuba, Allegany County	86,250
Marketed at Norwich, Chenango County	82 300
Marketed at Lowville, Lewis County, about	85,386
Seven combinations in Cattaraugus County	80 081
Total	990,000

These figures are as nearly correct as it is practicable to present. They represent approximately the production of the counties of Oneida, Herkimer, Chenango, parts of Madison and Otsego, Montgomery, Jefferson, St. Lawrence, Lewis, Oswego, part of Onondaga, Allegany, and parts of Cattaraugus and Chautauqua.

For the benefit of those who are not familiar with the cheese trade it may be well to state that "boxes" of cheese vary in size and weight, ranging from 34 pounds for a small sized home-trade cheese up to 75 pounds for large-sized export cheese. It has always been the custom at the Utica Board of Trade to estimate the average weight of boxes throughout a season at 60 pounds, and the same estimate was adopted by Hon. B. F. Van Valkenburgh, assistant dairy commissioner of this State, in making out his reports for publication. A similar result was arrived at by the secretary of the Watertown board, who wrote to a number of dealers and organizations for their views and published the answers. A large majority agreed that 60 pounds was a fair average weight for the cheese produced in New York. In the ordinary method of reporting the markets the number of boxes is given, and not the number of pounds. There is so much difference in the weights of the separate cheese that it would be wholly impracticable to figure out the exact amount in pounds. Therefore, in writing on the subject of the cheese trade in this State, it is customary to speak of the number of boxes instead of the number of pounds.

The only census from which it is possible to obtain the total production of cheese by counties is that of 1865. In that year the total product was 72,195,337 pounds. The same fourteen counties represented above gave 60,860,778 pounds, which was 84 per cent of the whole amount. Although this was thirty years ago, the relative proportion of cheese made in these counties is still as large as it was in 1865, or even somewhat larger. In the year 1892 the commissioner of agriculture of New York directed the assistants of his department to make a full enumeration of the cheese and butter factories in the State, including their production during that year. The same work was done again in 1894, and the figures for the last-named year showed a marked falling off during the two years that had elapsed. The statistics of 1892 placed the total production in New York for that year at 131,148,310 pounds; those of 1894 placed it at 115,760,345 pounds, showing a decrease of nearly 12 per cent. At the same time the number of cheese factories in operation had decreased from 1,156 to 1,032, but the number of creameries, or establishments where both cheese and butter are made, increased from 213 to 315.

In the enumeration of 1892 the fourteen counties for which partial figures of the past season have already been given produced 113,533,012 pounds of cheese. This is 86½ per cent of the whole, or 2½ per cent more than it was found to be in the census of 1865, which shows that these counties had made a slight gain in the relative proportion of their manufacture of cheese. The proportion of these counties to the whole State in 1894 was 86 per cent, a difference of only one-half of 1 per cent, and as this was the year just previous to the one we are attempting to estimate, it seems best to accept this proportion as the basis of an estimate for 1895.

It has been shown that in 1895 portions of fourteen counties produced 990,000 boxes of cheese. If this amount forms 86 per cent of the whole, by adding the remaining 14 per cent, or 171,730 boxes, a total of 1,161,730 boxes is reached, equivalent to 69,703,800 pounds. This represents what may be called the known quantity. A sufficient amount must be added to represent the unknown quantity included in the partial estimates of some of the counties, the quiet purchases of home traders, and the consumption of producers themselves. The shrinkage of trade at the Utica board since the agricultural census of 1892 has been about 13 per cent; that of Little Falls is over 27 per cent. The receipts of cheese in New York City in 1892 were 1,999,029 boxes; in 1895 they were only 1,259,990 boxes, showing a decrease of 37 per cent. The receipts of 1894 were 1,613,385 boxes, and this shows a decrease in one year of 22 per cent. These few figures demonstrate the difficulty of forming any accurate judgment of the yield based upon incomplete returns. At the same time it is believed that if the total already named be considered as representing two-thirds of the yield of the State last year, it will come very near the correct figures, which would stand as follows:

	Pounds.
Two-thirds (closely estimated)	69,703,800
One-third (approximated)	34,851,900
Total	104,555,700

In confirmation of this, it has been seen that the decrease in production, as shown by the census of the State commissioner, amounted to about 6 per cent per year from 1892 to 1894. In 1895, however, the drought was much more severe than in the two years previous, and the shrinkage must have been still more pronounced. If we allow 8 per cent decrease last year instead of 6, the total decrease since 1892 would be 20 per cent, and 20 per cent off 131,148,310 pounds brings it down to 104,918,648 pounds, which substantially agrees with the estimate given above.

STATISTICS OF EXPORTS AND IMPORTS OF CHEESE.

EXPORTS OF AMERICAN CHEESE.

In speaking of the exports of cheese, it has been thought best to use the figures for the whole United States rather than for the State of New York only, for two reasons: First, because the exports from New York City form such a large proportion of the total exports from this country; and, secondly, because the totals make the tale they have to tell more forcible and striking. To show the proportion of New York exports to those of the United States, the figures are herewith given for five years, from 1890 to 1894. They are taken from Assistant State Commissioner Van Valkenburgh's report, in which each year ends with the last of October.

Exports of American cheese, 1890–1894.

Year.	Exports.	
	From New York alone.	From all ports in the United States.
	Pounds.	*Pounds.*
1890	70,208,270	91,014,571
1891	61,299,205	77,148,794
1892	67,432,651	81,589,361
1893	53,293.060	67,925.712
1894	50,375,760	65,054,452

Taking these five years together, the proportion of the exports from New York to those of the whole country is a little over 79 per cent, and when we go back to the early years of exportation the proportion of New York is still greater. It seems evident, therefore, that whatever deductions may be drawn from the figures for the whole United States will also prove true of the exports from New York alone.

The statistics of our exports both of cheese and butter are much more satisfactory and available than those of production. Beginning with 1830, we have the exports for each year down to the present time, so that comparisons can easily be made. During the ten years from 1821 to 1830, inclusive, the entire volume of cheese exports was only 7,914,198 pounds. For the next ten years, to 1840, they were 8,247,795 pounds, an increase for the decade of only 333,597 pounds. But during the next decade there was an enormous increase, the business running up to 90,610,348 pounds, the exports of 1849 alone amounting to 17,430,000 pounds, or double the entire business of the 1830–1840 decade. It was a strange freak of trade, however, that the exports from 1850 to 1860 should fall off about 13 per cent and aggregate only 78,533,783 pounds.

In 1853 they ran down as low as 3,763,932 pounds, which was the lowest point they had touched in twenty years. And what makes it still more singular is the fact that this was during the first ten years after the introduction of the factory system. It is true that the system was on its trial during that period and made exceedingly slow progress, so much so that in 1860 only about a score of factories were in existence. Then, however, they increased so rapidly that in 1862 Mr. Willard enumerated 34 factories in Oneida County alone, and stated that Herkimer, Cortland, Jefferson, Lewis, and Otsego each possessed its own quota of factories.

In the year 1860 the exports rose from 7,103,323 pounds the year before to 15,515,799 pounds, and the next season to 32,361,428 pounds, and so on, with an irregular but pretty constant increase, until 1870–71, when the amount had risen to 63,698,867 pounds. The total for that decade was 446,512,816 pounds, an advance over the previous ten years of about 550 per cent. As a very large proportion of these exports went to Great Britain, it is reasonable that we should look for some cause for this enormous increase outside of the mere increase of manufacture in our own country.

Cause of increase.—It is believed that this may be found in Great Britain herself. In 1843 there was a duty imposed on cheese imported into that country of 5s. per hundredweight. In 1853 this duty was reduced to 2s. 6d. per hundredweight, and in 1859 the duty was abolished altogether. There is a striking coincidence, to say the least, between this fact and the doubling up of our own cheese exports in 1860, together with their continuous increase for the next ten years. By 1874–1875 our foreign trade in cheese had reached the hundred millions mark, and only once down to 1883 did it fall below that mark, and that occurred in 1875–76 when the exports receded 3,330,000 pounds. The decade from 1871 to 1880 came near reaching a thousand millions, the exact figures reported being 999,924,409 pounds. The exports of the years 1884 and 1885 exceeded a hundred millions each, but never since then have they reached that point. The figures are herewith presented in tabular form, and are for the commercial years as known to the cheese trade, including twelve months ending on the 30th of April of the years named.

Exports American cheese, 1881–1896.

Year.	Cheese exported.	Year.	Cheese exported.
	Pounds.		*Pounds.*
1881	147, 995, 614	1889	84, 999, 828
1882	127, 989, 782	1890	95, 376, 053
1883	99, 220, 407	1891	82, 133, 876
1884	112, 869, 575	1892	82, 100, 221
1885	111, 992, 990	1893	81, 350, 923
1886	91, 877, 235	1894	73, 852, 134
1887	81, 255, 994	1895	60, 448, 421
1888	88, 008, 458	1896	33, 977, 040

The flood tide of our exports occurred in the year 1880–81. Once before, in the year 1878–79, they rose to 141,654,474 pounds, but in no other year did they reach 128,000,000. The really serious decline began in 1885–86, when the exports fell off 20,000,000 pounds, and amounted to slightly less than 92,000,000. The rally in 1889–90 came partly from a light make of cheese in England and a very heavy one in this country, and consequently lower prices than had been experienced since the season of 1879. For three years after that the exports remained about on the basis of those of 1887, but in 1894 they declined 7,500,000 pounds, and in 1895 they met with another decline of 13,400,000 pounds. The year just past, however, is far worse than any year since 1866, when the exports were 34,052,678 pounds, and it compares very closely with that.

Included in the amount of these exports are the cheese which go over the northern border of New York in the summer time to Montreal and thence to England. Ogdensburg is the principal point from which these exports are made, although the statistics of that office include all the stock which is shipped at Clayton and Alexandria Bay, as these two ports are in the Ogdensburg district. There are also small shipments made from Cape Vincent. The figures are as follows for the season of 1895:

Exports cheese via Canada.

Shipments from—	Pounds.	Value.
Ogdensburg	4,350,384	$320,136
Cape Vincent	63,824	4,808
Total *a*	4,414,208	324,944

a In 1885 the writer obtained the figures of exports from these same ports. They amounted to 2,403,857 pounds for that year, showing that in ten years they have increased nearly 90 per cent.

This is all northern New York stock of the best quality, a large portion of it uncolored. It represents less than 5 per cent of the cheese manufactured in the State last year, but it also represents about 13 per cent, or one-eighth, of the entire exports of the country during the year 1895. A large proportion of the cheese made in northern New York is white; it is also acknowledged by dealers to be as fine as any produced in this country. For both of these reasons it is sought after by Canadian buyers, and the statement is made that considerable of it is branded "Canadian cheese" before being shipped to the old country. Unfortunately, this is considered a compliment to the stock, which no doubt sells better for being so branded; otherwise the brand would not be put upon it. At certain seasons of the year there is a lively competition for these goods between Montreal and New York, but when the market is active Montreal is liable to get the lion's share, on account of lower freight rates in that direction, which enable Montreal buyers to pay better prices than New York buyers can.

The causes of decrease.—The exports of cheese from this country are therefore down to a point which had been reached thirty-four years ago, when the factory system was comparatively new and there were only about 400 factories in this State. There must certainly be some strong reasons for such a remarkable decline in the business within ten or twelve years. During that period the exports of Canadian cheese have increased almost as rapidly as ours have decreased, and the relative positions of the two countries have been almost exactly reversed. It may be well to see what was said about our cheese in 1866. Mr. X. A. Willard, who had been sent to England the year before by the American Dairymen's Association, to investigate the methods of manufacture there, said in the convention of 1866:

> I have given them (English makers) the credit of producing a limited quantity of cheese of the finest type that has ever been reached by any manufacturer; but the quantity is comparatively small, and when the whole bulk is considered, there is nothing like the richness and uniformity of that from our factories.

Three years later, at the convention of 1869, Mr. John M. Webb, a New York dealer and exporter, related some of his experience abroad. He said:

> During my visit to London last October, I went through a carefully selected stock of over 10,000 boxes of New York State cheese, with one of the largest and most experienced cheese factors in the south of England. The inspection was close and critical. When it was concluded, I asked two questions. The first was, "How do these cheeses compare with the English make of the current season?" Said this most competent authority, "The season has been so unfavorable that I don't think I could get returns of equal quality in all the south of England." I then asked, "How does the stock we have been looking through compare with the best English cheese of an average season?" The reply was, "They are just as good, and I did not think it possible to get together so many fine American cheeses."

Mr. Webb afterwards said that later in the season this cheese developed a lack of keeping quality, which seems to have been always one of the most serious faults with American cheese. These quotations, however, show that twenty-five or thirty years ago our cheese met many of the requirements of English dealers and consumers, and took the lead of all imported cheese in the English markets.

What has taken place since that time? The cheese trade of Canada can hardly be said to have made a beginning thirty years ago, while that of the United States was easily ten times as large as our neighbor's. In the year ending May 1, 1896, the proportion of exports is about 5 for Canada to 2 for the United States. Evidently there must be something radically wrong with the manufacture of our cheese to bring about such a change as this. It has been suggested that, on account of the frozen meats brought from Australia and South America to England and sold at lower prices than ever before, the consumption of cheese has declined in the latter country. There is undoubtedly some force in this argument, for we find that while the Canadian exports of cheese in 1894 were 1,726,058 boxes, which was the highest point they have ever attained, in 1895 they were 10,000 boxes less, thus showing a slight falling off there also. For the last three or four years the imports from Australasia have been a comparatively steady quantity, and any small increase of these imports would do very little toward making up for the 400,000 boxes shortage in the imports from the United States in the year ending April 30, 1896.

It seems evident therefore that the consumption of cheese in England has materially decreased within a short period of time. The same thing has happened with pork. A recent English writer says:

> It is generally considered that one of the chief causes of the low price of pork is the establishment in the country districts of shops for the sale of imported beef and mutton, which has been retailed at 3d. to 6d. per pound. A leg of 2-year-old wether mutton at 6d. per pound has been too great a temptation to countrymen, and the consumption of pork is not half as large as within recent years in the country districts for bacon-curing purposes.

Exactly the same thing may be said of cheese. The English countryman prefers to eat mutton rather than cheese, the price of both being the same. And that accounts in some measure at least for the decrease of 400,000 and odd boxes of cheese which the English imports showed last year.

But this is not the only reason nor the most serious one. As has already been said, there is something radically wrong with our cheese itself—something which has been gradually developing for several years past, but the effect of which was not fully appreciated until last season. As long as ten or twelve years ago the manufacture of "filled cheese" was being carried on in a small way by people in the Western States, where there were no prohibitory laws against it. In fact the article was originally made in New York at least as early as the year 1880. Several patents were issued to cover the special processes by which the cheese was made, and down to 1884 a lucrative business was carried on by the few establishments which had adopted its manufacture. But in the year 1884 the New York legislature passed a series of restrictive dairy laws, and created a dairy commissioner with a staff of officials to see that the laws were enforced. The men who owned the patents, as well as those who had been using them, at once conformed to the statutes, being law-abiding citizens, and no filled cheese has been made in the State since that time. But a year or two later the process was taken up in Illinois and then in Wisconsin, and its manufacture has been carried on with increasing volume. The result has been exceedingly disastrous to the cheese trade of the whole country. In two directions the sale of filled cheese has done harm to our dairy interests. One of these was abroad, the other was in the Southern States. It may be advisable to speak of these separately.

The injury done to our foreign trade by this product of skim milk and some foreign oleaginous substance to take the place of butter fat is not a new thing. It extends back for a number of years, and its results appear to be cumulative. When filled cheese was first sent abroad, it was not recognized as such. It went along with other goods which were the genuine article, and as no statement was made in regard to it, the receiver naturally accepted it as full cream, or, at least, as a lightly skimmed cheese. So long as it was sold and eaten within a short period after its arrival, there was no suspicion of its genuineness. But after a while the stuff began to show its natural badness and to deteriorate very rapidly. Those who bought it lost money on it. This went on from season to season, and each year the English buyer became more and more suspicious of cheese from "The States." There was no guarantee of genuineness except the New York State brand, and not only did many of our State factorymen neglect to use this, but Western full creams could not be branded with it, while Western filled cheese often was branded with some inscription that was intended to convey the impression that the goods were not imitation, but genuine. This tended to discredit all cheese from this country, including that which carried the New York State brand. In the early winter of 1895 Wisconsin passed a prohibitive law in effect similar to that of New York. This removed her from the rank of counterfeiters, leaving Illinois to carry on the traffic alone. Canada had already seen her great opportunity and passed laws prohibiting the manufacture or sale not only of filled cheese, but of skimmed cheese also, and, in fact, of everything except full cream cheese, the pure product of cows' milk. This law has spiked our guns during the past year and rendered us comparatively helpless. Without it we might have divided the 400,000 boxes, of which the English imports are short. If our cheese had been all right, there can be little doubt that the decrease of consumption in England would have made a serious falling off in the Canadian exports as well as in our own. As it is, the English know Canadian cheese to be genuine, while all the United States product is more or less suspected; therefore they buy the Canadian in preference, and leave us to bear alone, practically, the whole of their decreased consumption.

IMPORTS OF FOREIGN CHEESE.

An analysis of the importations of cheese into this country may be of interest to the cheese maker. Previous to the year 1885 the importations of cheese, butter, and milk were all pooled together and only the total value of the whole was reported each year. But in 1885 the custom-house authorities began to report each of these articles by itself, and it will aid the reader in making comparisons to have the table of cheese importations before his eyes.

Imports of cheese, 1885-1895.

Year.	Cheese.	Value.	Year.	Cheese.	Value.
	Pounds.			*Pounds.*	
1885	6, 247, 560	$964, 587	1891	8, 863, 640	$1, 358, 752
1886	6, 309, 124	855, 570	1892	8, 305, 288	1, 238, 166
1887	6, 592, 192	874, 261	1893	10, 195, 924	1, 425, 927
1888	8, 750, 185	1, 214, 936	1894	8, 742, 851	1, 247, 198
1889	8, 207, 026	1, 135, 184	1895	10, 440, 863	1, 471, 091
1890	9, 263, 573	1, 295, 506			

It should be said that down to 1895 these figures represent the even year from January to January, but in 1895 they are the imports from July 1, 1894, to June 30, 1895, which represents the fiscal year. For practical purposes, however, it is about the same. It will be seen that our imports have increased 67 per cent in the eleven years enumerated above, while our exports during the same period have diminished in just about the same proportion. At an average price of 8½ cents for the cheese sent abroad the past year the value of our exports is only as much again as the money paid out for imports. Nearly a million and a half of dollars was paid to foreign countries for cheese delicacies, a portion of which might be made at home if our dairymen and cheese makers would only do their work in the right and proper way.

In order to understand the situation more clearly, a special analysis of the imports for the year 1895 will be found useful. The following table gives the countries from which cheese was received, the number of pounds from each, and the value of the same in dollars:

Amount and value of importation of cheese for the year 1895, by countries.

Country.	Quantity.	Value.
	Pounds.	
United Kingdom	125,411	$24,824
France	832,940	139,562
Germany	400,710	52,261
Italy	3,048,762	454,651
Netherlands	929,327	109,589
Switzerland	4,834,961	657,931
Other European countries	215,236	25,346
British North America	37,664	5,380
Other countries	15,852	1,547
Total	10,440,863	1,471,091

It will be seen at a glance that the importations from Switzerland and Italy comprise more than three-fourths of the whole amount, and that of the remainder the Netherlands contribute about 36 per cent and France about one-third. The cheese from France is principally Roquefort, Camembert, and Brie. Of these last two varieties we make a certain amount, but they do not compare favorably in quality with the foreign goods. The stock imported from the Netherlands is composed chiefly of Edams, although there are also a few Goudas. Some attempt has been made to produce Edams in Wisconsin, but it has not proved to be a success. So far as can be learned, there ought to be no serious obstacle to producing a fine quality of Edam in this country. There is a lucrative business awaiting the man who will resolutely set about making a choice article of Edam cheese in New York. It will require some capital and considerable patience, as the cheeses ought not to be marketed until they are three to five months old. But if they are made fine enough to sell for any such price as the foreign Edams bring their manufacture will pay a handsome profit. American sweitzer is made not only in New York, but in Ohio, Indiana, Michigan, Wisconsin, West Virginia, and on the Pacific Coast. The product of Wisconsin is decidedly preferred to that of the other States by dealers in New York City. At the same time it is far from being equal to the imported Swiss cheese, as is shown by the prices at which it sells. The foreign article was sold by importers in the early winter of 1896 at 19 to 20 cents, while the same parties jobbed American sweitzer at 12 to 13 cents. There could be no such difference as this if there was anything like a parity in the quality of the two. Nearly 5,000,000 pounds of imported Swiss cheese is used in this country. The quantity made in the Western States is uncertain, although it is probable that Wisconsin produces about 1,250,000 pounds. It is a liberal estimate to put this manufacture in New York at 300,000 pounds, and that of the other States at 950,000 pounds. This would place the entire make of Swiss cheese in this country at 2,500,000 pounds, which is about one-half of the amount imported. It shows that there is a wide margin here for the improvement and extension of manufacture of this class of goods also.

The importations from Italy consist of seven varieties, viz: Romano, Reggiano, Parmesan, Gorgonzola, Caccio Cavallo, Formaggio di Bra, and Canestrato. Of these, the Romano is most largely imported, while Parmesan and Reggiano come next. Of the other four varieties only small quantities of such are brought over, three of them belonging to a class which may properly be called noncivilized cheese. The Romano variety is made from the milk of buffaloes, of which animal there is a species bred in central Italy much smaller than our bison. Their milk contains hardly any butter fat, and there would seem to be no great hindrance to the production of Romano cheese in this country out of skimmed milk, providing the correct method of manufacture was followed and the requisite time given for curing. But it is not probable that Parmesan cheese could be produced here successfully, as even the Swiss, who have tried it on the southern slopes of the Alps, have not been able to succeed. It seems to be a product peculiar to the plains of the Po and to the soil and pasturage belonging to that region.

Reggiano, which is made of full cream, is a mild and wholly civilized cheese, but requires long age to perfect it, inasmuch as it is never eaten less than a year old, and from that up to four years old. Its shape is that of a small-sized flat cheese made for home trade; but its exterior is black, though smooth, being rubbed occasionally with a preparation of lampblack and linseed oil to keep away flies during the long process of curing.

FANCY CHEESE.

DIFFERENT VARIETIES MADE IN THE STATE OF NEW YORK.

In addition to the ordinary styles of cheddar and flat cheese there is a considerable amount of "fancy" cheese made in this State. This includes the different varieties of foreign cheese, together with soft cream cheese and what is known as "pineapple" cheese, which is a distinctly American variety. The principal varieties made here are as follows: Limburger, domestic Swiss, Münster, Brie, d'Isigny, Neufchâtel, Hand, Wiener, and Camembert. Limburger has been so successfully made in this country that the domestic article has practically superseded the foreign, and very little of the latter is now imported. One reason for this appears to be that Americans do not like the cheese as strong as foreigners want it. In this country it is put on the market and consumed when it is from 1 to 2 months old, at which age it has not acquired the very strong, rank flavor so much admired abroad. The Münster cheese is a milder and more solid form of the same class of goods. The Swiss cheese made in New York differs from the real Swiss in not having the gases so largely developed, and hence in being a more solid cheese and containing fewer and smaller holes. It is also marketed when only 3 to 4 months old, whereas the genuine Swiss cheese is kept in the curing house for eight or nine months, which allows it to develop a richer, more aromatic flavor. Here again, however, the American taste for a fresh and comparatively mild flavor in cheese is met by the domestic manufacturer. In the home-made Brie and d'Isigny this tendency is still more pronounced. Both of these varieties are sold at 2 to 4 weeks of age, when they are not much more than curd, and have hardly developed their distinctive qualities or have developed them in such a partial degree that they can hardly be classed as one thing or the other. The Hand Kase is a soft cheese, which needs to be marketed as soon as made, which is also the case with Wiener, Neufchâtel, and cream. Some of the domestic Camembert is said to be a fair substitute for the imported.

PRINCIPAL FACTORIES WHERE THEY ARE MADE.

There are three establishments for making fancy cheese in Orange County. The largest of these was established in 1873, and its principal business is in Neufchâtel and cream cheese, although it makes a little Fromage de Brie and d'Isigny. A Frenchman had come to the county and manufactured Neufchâtel some time before, but had not made a business success. The present proprietors bought out the interest of this pioneer and continued the enterprise. During the first year they used not more than 20 quarts of milk a day in the manufacture of the cheese, but gradually the business assumed larger proportions. Then a well-known New York firm sent for the senior proprietor and told him that they wanted for their trade a richer and more delicate cheese than anything to be found in the market and asked him if he could not devise something of that kind. After studying the subject for some time he produced the rich, soft, cream cheese which is now such a favorite among cheese lovers, and which has been so extensively copied and reproduced by other establishments. The origin of this variety of cheese should therefore be credited to Orange County and the establishment referred to. At first the Neufchâtel was packed in empty starch, raisin, or soap boxes, which could be bought cheaply from grocers. These held from 112 to 248 cakes of the cheese, which were at that time simply rolled in tissue manila paper and packed in the boxes, with straw to fill the interstices. At length it occurred to the makers that it would be much better to have boxes made of the exact size to hold a certain number of cakes; so boxes holding 200, 150, and 100 cakes were tried, and it was very soon found that those holding 100 were most in demand. Then others were made to contain 50 cakes, and finally only 25, and with each change the business showed an increase. Along with the change in boxing came other improvements, such as substituting white parchment paper for manila, and outside of this tin foil stamped with a trade-mark and the name of the cheese. The same results followed these improvements as when ordinary factory cheese were first put into single boxes instead of casks—the neater appearance of the goods largely increased their sale.

The cheeses of this firm are sold in all the large cities of this country, from Boston to New Orleans. They even go to the Pacific Coast, and, what is stranger still, there is a steady and increasing demand for them in the island of Cuba. The war in Cuba does not seem to have caused any diminution in the sale of cheese there. The firm continues to ship weekly an average of more than 100 cases to the island. Ordinarily in the Eastern States the cheese is consumed within a few days after being made, and when asked if it did not acquire a sharp taste after a long voyage by sea or overland, the originator said he had never eaten it in the tropics, but had tried it in Western Oregon, and had found it all right there.

This establishment is very complete, and may be taken as the type for this class of manufacture. About 200,000 feet of lumber is used annually, the wood being cut and put up in shooks about 100 miles away. A printing machine has recently been purchased for putting the imprint on the outside of the boxes, which has hitherto been done with a stencil plate. With this the printing will be done directly upon the wood. The manufacturing rooms occupy the entire basement of the large building, and are floored throughout with stone. A 75-horsepower boiler runs the machinery. All the utensils and cloths are cleansed by steam. The curd, after draining as much as it will in the sinks, is put under powerful presses in bags, about a dozen under each press, of which there are long rows through the middle of one end of the basement. Of course large quantities of extra cream are used to enrich the cream cheese, and this is obtained by three large separators. The milk is put into the separators warm and fresh, but as the cream runs out it drips over a range of pipes filled with brine, and even in the warmest weather when the cream reaches the cans into which it drips it is cooled down to 36° or 38° F. The large curing rooms for hot weather are also cooled with brine pipes. The skim milk is all carried by gravity to a tank outside the building, and from that is forced up to another tank on a hill 3,500 feet away. There it is used for feeding hogs, of which about 400 are kept continually in the pens. This is one of the profitable features of the establishment.

During the first winter this concern only used about 200 quarts of cream the whole season; now over 800 quarts of cream are used per diem. The total amount of milk used in the year 1895 was something over 3,250,000 quarts. Three millions of this was used in the manufacture of cheese, the rest in producing cream, which was sold in its natural condition. In round numbers, 6,000,000 pounds of milk was converted into cheese, the product of which would average 600,000 pounds of cheese. The low prices of Cheddar cheese in 1895 did not affect the price of soft cheeses to any considerable extent, nor does the season of the year affect them. From January to January they sell at the same prices. This system has its advantages and its disadvantages; for, should the New York price of milk average high, the manufacture of fancy cheese must be conducted at a loss, the milk being bought from the dairymen on the basis of prices at the New York city market.

The sale of fancy cheese is increasing rapidly, and the enormous falling off in our export of Cheddar cheese will, if it continues much longer, compel the factory men to enter upon some other branch of the business. While it is manifestly for the interest of this factory that the number of factories making soft cheese should continue to be limited, the proprietors can not help expressing the conviction that sooner or later our factory men will have to resort to the manufacture of a better article of Cheddar, or to a first-class butter, or to different varieties of cheese, in order to make a market for the milk.

Of the other two factories of a similar kind in Orange County, one makes only Brie and d'Isigny, and the other adds Camembert, Caprera Cream, Neufchâtel, Kümmel, Liederkranz, and Kappen cheese. The proprietors of both are native Swiss, and learned the art of cheese making in their own country. In the case of the older factory, its operators spent seventeen years in Normandy, France, where they perfected their knowledge of the Brie process. Coming to this country, they opened a factory for the production of foreign varieties of cheese, and for a time they made Camembert also, although recently they have given this up. They were the originators of the variety called "d'Isigny." When asked how they came to give it that name, they replied that, as Isigny butter was the best butter made in France, they desired to make their Fromage d'Isigny the best cheese in the United States. But as soon as the cheese began to acquire a reputation other makers imitated it and used the name, although it properly belonged to their manufacture only. At the World's Fair in Chicago their Brie, d'Isigny, and Camembert all took first prizes, and several of the leading hotels and most fashionable restaurants in New York City use their goods. The cheese is principally marketed in New York and Chicago. They hold their prices firm and do not change from year's end to year's end. They use in round numbers 1,160,000 pounds of milk yearly, which gives them a production of about 116,000 pounds of cheese.

Another factory is situated in the village of Monroe. This establishment is now managed by a Swiss maker, and produces a greater number of varieties of cheese than the other two factories. Its manufacture comprises Brie, d'Isigny, Camembert, Caprera Cream, Neufchâtel, Kümmel, Liederkranz, and Kappen cheese. More of the two varieties first named are made than of the others, and in the winter season the racks are well filled with stock, ranging from perfectly new to 3 and 4 weeks old. They handle about the same amount of milk as the factory described above and produce about the same quantity of cheese annually.

Another large establishment of the same character, and one of the largest in the United States, is located in Jefferson County. At this factory are made Brie, d'Isigny, Camembert, Neufchâtel, Square Cream, Wiener, Münster, Limburger, Stilton, and in the summer time some American. The variety that is made in largest quantity is d'Isigny, and Neufchâtel comes next. Their goods are marketed in all the large cities of the United States. Most of them are sold at 20 to 30 days of age, except the Cream and Neufchâtel, which are shipped fresh. The factory handles about 15,000,000 pounds of milk annually, which in round numbers amounts to 1,500,000 pounds of cheese. The business increases from year to year, and the low prices of Cheddar cheese last season seemed to make little if any difference in the prices of their goods. Their plant is furnished with all sorts of machinery for doing the work and with every device for saving time and doing away with manual labor. The company has in its employ men from different parts of Europe who make special kinds of cheese by the same processes that are used abroad.

Still another is located in Chenango County and does a large business. Its headquarters are in New York City, where it does a large importing business also. The staple varieties of their manufacture are Neufchâtel, Philadelphia Cream, Saratoga Cream, Brie, and d'Isigny, besides which they make some Münster, Hand, English, and State factory cheese in summer when there is a surplus of milk. The manager of their factory turns out besides cheese a large amount of butter, which is unsalted, uncolored, and is put up in prints for the New York market. During the year 1895 the company received 3,470,516 pounds of milk, from which they manufactured the following amounts of cheese:

	Boxes.
English Dairy cheese	4,230
Neufchâtel	28,789
Philadelphia Cream	10,625
Fromage de Brie	6,272
Fromage d'Isigny	10,927
Hand Kase	1,800
Münster	950

Averaging the cheese at 10 pounds to the hundredweight of milk, the total cheese made by this company would be 347,051 pounds. The name "Philadelphia Cream," for cheese, is secured to this establishment by copyright.

A cheese of peculiar size, shape, and appearance, and known as the Pineapple, is made in Wyoming County. This style originated with the family which still controls its manufacture. These cheeses are made in three sizes, viz, 2, 4, and 6 pounds, the larger size being put up four in a box, the others seven in a box. They are jobbed at $2.75 per box. Last year was about an average season for the business, but prices were a trifle lower than before, being somewhat affected by the decline in Cheddar cheese. These goods are marketed in all the large cities of the land. Sixteen per cent of extra cream is added to the milk from which the cheese is made, thus creating a rich and delicate product that finds favor with many consumers. The cheese will keep perfectly for two or three years; hence there is no danger of loss to jobbers or retailers who handle it. The season of manufacture is from the first of April to the middle of November. About 1,000,000 pounds of milk were used by this firm last year, which produced 100,000 pounds of cheese.

Still another establishment which manufactures small cheese and English Dairy cheese that go through a special process and are cured much longer than our ordinary stock before being sent to market, is located at Gilbertsville, Otsego County, N. Y. The firm owns a dozen factories, scattered through different towns in that county, and their manufacture consists principally of fancy small cheeses of different sizes. Last year the production was as follows:

Styles.	Quantity.
	Pounds.
English Dairy, 19 pounds each	354 443
Table cheese, 4 pounds each	16,000
Fancy uncolored:	
10 and 20 pounds each	82,916
24 pounds each	246,735
Total	700,094

It takes the English Dairy cheese from five to six months to cure sufficiently to be put on the market. They are sold principally in New York, Boston, Philadelphia, and Baltimore. The Table cheese has to be cured about the same length of time. The smaller uncolored cheeses are ready for market in thirty days, and are made especially for New York customers. The larger uncolored fancy cheeses are made for the Boston market. These are made soft, and are ready for market at twenty days old. It is understood that a considerable proportion of the cheese which is sent to New York and Boston goes directly to private families, on orders, just as a good deal of the fancy butter made in private dairies is supplied to special customers. This is the most desirable trade to have, as it saves the commission of a middleman.

The total amount of fancy cheese annually manufactured by these seven establishments is about 3,500,000 pounds.

MANUFACTURE OF LIMBURGER, SWEITZER, AND MÜNSTER.

In addition to these special factories there is a considerable number of establishments in Oneida, Lewis, and Jefferson counties which manufacture Limburger, Swiss, Münster, and Stilton cheese exclusively. In the report of the New York State commissioner of agriculture for 1893, 57 of these factories are named, 2 of which, for the manufacture of Swiss cheese, are in Erie County. The total product of the 57 establishments in the year 1893 was 2,629,142 pounds, which was included in the sum total for that year already given, as was also the product of the other fancy cheese factories. Although there was very little diminution in the product of the latter last year, it is quite probable that the product of the Swiss and Limburger factories decreased last season in about the same ratio as that of the Cheddar factories, as they were subjected to the same climatic influences. The amount of Limburger produced is far in excess of all the other varieties put together, 40 factories making 2,003,070 pounds. There are, besides, 8 factories which made both Limburger and Swiss cheese, and these produced 181,256 pounds. The 6 factories that are devoted entirely to the production of Swiss cheese made 231,121 pounds. Five factories, which made Stilton and other fancy brands, produced 158,695 pounds, and the product of 2 factories in which only Münster is made was 55,000 pounds. Of course, the product of this whole business is small, being only a trifle over 2 per cent of the entire amount of cheese made in the State, or, counting in the other fancy cheese, about 6 per cent of the whole. There is, therefore, ample room for an increase in the production of fancy varieties, providing they are made sufficiently palatable to tempt the tastes of our own population. That must be the criterion for success. There are as yet no Edams made in this State, although, with the exception of Swiss and Italian cheese, the largest importation of any foreign variety consists of Edams. There is a clear field open for the maker who will produce this cheese of such a quality that it will compete with the importations from Holland. It is doubtful if Roquefort cheese can ever be successfully produced in this country, on account of the requirements for curing it, unless the time shall come when any variety may be reproduced by the introduction of the proper bacilli. Such a result seems to be the dream of the dairy bacteriologist of the present day.

While the amount of Brie cheese made in the State is comparatively large, it does not yet rival its French namesake in delicacy and palatability. Further improvement in its manufacture will doubtless create a greater demand and a wider market for it. Some of the Camembert made here is really good, but not yet equal to its foreign competitor. But for the production of any European variety with success, a special study must be made of our soil and grasses and of the conditions of our climate. Above all, our dairymen must learn to exercise the same care and neatness in the treatment of their cows and milk that is found in the Swiss and Dutch dairies. In the countries which produce those fine varieties of cheese the cow stable is often an integral portion of the house and is kept with the same scrupulous neatness. Of course it is not necessary that our dairymen should build the house as an attachment to the stable, or should put the manure pile in the front yard, as is commonly done in continental countries, but it is necessary that they should keep the stables free from manure and from bad odors, that they should give clear, pure water to the cows, and that the cows and their udders should be kept as free as possible from manure or dirt of any kind.

An expert opinion on the requisite dairy work.—A member of one of the largest cheese importing houses in New York, himself in early life a practical cheese maker in Switzerland, when asked his opinion as to the manufacture of foreign varieties in this country, said it would be of great value to our dairymen, not more on account of the money to be made by it than for the special care it would require to be given to the cattle and to the general work of the dairy in order to produce fine qualities of cheese. It would have a tendency to compel the dairyman to take more rational care of his cattle and their food. Certain weeds in the pastures are very detrimental to the manufacture of such cheese, and they ought to be grubbed out as they are in European countries. The cows also should receive more attention than is customary in America, to obtain the largest possible quantity of milk and especially the finest quality. The manufacture of Yankee cheese requires less care, punctuality, and cleanliness in milking, and the firm buys its American Sweitzer from makers preferably of Swiss or Dutch birth and education. The Yankees are too careless. Swiss cheese has to undergo a long process of fermentation, and bad milk shows itself during this process and makes bad places in the cheese.

The main point in the above opinion is coming to be a vital one among cheese dairymen. The first requisite for making good cheese is clean and wholesome milk. This is the foundation of the dairy business, and until the farmers themselves appreciate this and strive to produce such milk, all efforts of the makers of cheese must be more or less ineffectual. A great deal has been said and written on cleanliness in the dairy, but when dairymen think of that subject they generally apply it to the utensils and receptacles of the milk and manufacturing rooms. It must, however, go back of all that and be applied to the external condition of the cow, to her daily surroundings, to the hands of the milker, and to the care taken in milking. The condition in which the bowl of a separator is left, after a mess of milk has passed through it, is enough to convince anyone who has seen and smelt of it that a mass of filth is to be found in average milk as it comes from the average milking stable. The average farmer is too apt to think that the factory man who insists upon having clean, untainted milk is a crank, and to neglect the regulations prescribed by him for obtaining a pure article. But the truth is that our cheese will never reach the standard of European quality until this fundamental cleanliness in the care of the cow and the milking is understood and adopted by our dairymen.

DAIRY BOARDS OF TRADE IN THE STATE OF NEW YORK.

THEIR HISTORY AND PURPOSE.

Dairy boards of trade were first instituted in this country in the year 1871. The first meeting for the purpose of organizing such a board was held at Little Falls March 6, 1871, and the first sales day was May 1. Utica was next in the field, and made its first sales on May 29, while Sinclairville, Chautauqua County, came third, its sales day occurring on June 1. These three markets started within a single month, and Hon. X. A. Willard, of Little Falls, was the leading spirit both at that place and at Sinclairville.

The purpose of these organizations was primarily to help the dairymen. Previous to that time buyers often took advantage of the factory men, who were not as well informed on the markets as the buyers and might not know that an advance was taking place until several days after it had begun. By organizing into boards of trade and not selling cheese at the factories, but only at the weekly meetings of the boards, where the latest quotations were posted in plain sight, the factory men protected themselves against buyers who might be disposed to take advantage of them and were prepared to act with intelligence and in accordance with the latest news of the market. The popularity of these boards is evidenced by the fact that there is not a section in the State where a large cheese interest exists which has not some institution of the kind. At Canton, Watertown, Ogdensburg, Fulton, and Boonville, besides the places already named, regular organizations have been formed, while at Gouverneur, Norwich, Lowville, Cattaraugus, and Cuba a regular weekly market is held without any formal organization. The years when the regular boards were first established are as follows: Little Falls, Utica, and Sinclairville in 1871; Canton, 1876; Watertown, 1879; Ogdensburg, 1880; Fulton, about 1882; Boonville, 1894.

Utica has been the heaviest cheese market in the country from the start. There were two reasons for this: It could always be reached in a night by buyers from New York, and there was more full-cream cheese to be had there than at Little Falls. The transactions of 1871, the first year of the Utica market, were only 45,000 boxes. In 1873 they ran up to 100,000 boxes. In 1877 they had reached 210,713 boxes. The next year (1878) they were 322,535 boxes, but it was ten years before another hundred thousand had been added to this. In 1888 the transactions amounted to 409,564 boxes, although on account of lower prices the value of cheese sold was $2,187,071, against $2,415,581 the year before, when the sales were 22,000 boxes less. Even in 1889, when transactions reached the largest total ever known on that market, viz, 441,386 boxes, the value of cheese sold was only $2,294,500 because of still further shrinkage in prices. While therefore the heaviest transactions took place in 1889, the sales brought the largest amount of money in 1887. Since 1889 the amount of cheese marketed here has gradually shrunk away, until in the year 1895 it was only 218,545 boxes, which brings it down within about 8,000 boxes of the marketings in 1877. The average price also was so much lower than any other in the history of the board that the value of the cheese was only $1,002,859, against a value of $1,077,431 in 1876, the first year that values were reported, and when the transactions were only 167,355 boxes. One cause of the falling off in sales at Utica was the establishment of the board of trade at Boonville in 1894, which drew off about 40,000 boxes that were formerly marketed at Utica. Another cause that has operated increasingly for several years past was the building of milk stations (for city supply) on railroads running south from Utica, which took away a great deal of milk that was previously carried to cheese factories. These causes show that the heavy shrinkage of transactions at this market in the last six years is due only partially to a diminution in the production of cheese. Nearly all the milk, however, which is taken to the stations was formerly converted into cheese, and there is no doubt that even in a good year for feed the cheese production would now show a heavy decrease in comparison with that of 1890. Milk routes are gradually extending farther and farther into the interior of the State, and stations have been built in 1896 on roads that have never before carried milk. All this is of course a help to those who remain in the cheese dairying business, as it will leave just so much less of their product to be marketed and make it easier to dispose of. Generally speaking, all the milk that is taken to the stations and sold to go to New York, at least in cheese-making sections, has formerly been taken to the cheese factories and would go there now if it were not for this new outlet.

METHODS OF SALE AND SHIPMENT.

Nowadays cheese is never brought to the boards of trade when the factory men go to make their sales. Buyers know the factories by their reputation, and they often drive through the country to examine the cheese on the shelves. Besides, when they buy the cheese there is a tacit understanding, or sometimes a positive agreement, that the stock must come up to a certain standard in quality, especially when it is recommended and bought as first quality. When it arrives at its destination it is examined by an inspector, and if it is found to be inferior the factory is obliged to submit to a reduction in the price. Sometimes a few boxes only are not up to the standard; in this case these few are "rejected" and sold in open market for whatever price they will bring, and the factory bears whatever loss there may be on them. Cheese is shipped from the factory to any point the buyer may direct. If a buyer sells to a Western firm, or rather buys for one on an order, he directs the cheese sent straight from the factory to that firm. When going to New York they are often shipped two or three days before the meeting of the board in the shipper's own name, and at the board the bill of lading is turned over to whatever buyer happens to take them.

CHEESE FACTORIES IN NEW YORK.

INTRODUCTION, INCREASE, AND PRESENT NUMBER.

The story of the introduction of cheese factories has been so often rehearsed that it is not necessary to repeat it here. But it may be desirable to note certain facts in relation to their increase and management that are not so well known outside of those dairymen who keep close watch of the statistics. It has already been stated that the first cheese factory was started by Jesse Williams in Oneida County in the year 1851. The advantages of such an establishment soon became apparent to dairymen who possessed the privilege of living near it, but the knowledge of these advantages was slow in spreading through the other States. In the report of the New York State Agricultural Society for 1862, Mr. Willard enumerates 34 cheese factories in Oneida County in 1861, ten years after their introduction, and says there are other factories in Herkimer, Cortland, Jefferson, and Lewis counties. At the same time, he says the system "has not been sufficiently tested to render it certain that it is to displace entirely the old methods." Under most of the censuses that have included dairy statistics, cheese factories and creameries have been put together, and the total number of the two combined has been given instead of the number of each separately. This makes it difficult to state what the number of cheese factories was in any particular year. According to Bulletin No. 1 of the Dairy Division of the Department of Agriculture at Washington, there were 269 factories in New York in 1864, 484 in 1865, 818 in 1870, and 1,018 in 1875. In 1880 the whole number of factories and creameries was 1,652, while in 1890 they seemed to have diminished to 1,337. In 1893 the State commissioner of agriculture made an enumeration which showed the existence of 1,156 factories and 213 creameries, a total of 1,369, or a small increase over 1890. Again in 1894 a similar enumeration was made, showing 1,032 factories and 311 creameries, or a total of 1,343, a diminution of 26, which brought the number down to within 6 of the number in 1890. These are the latest statistics taken, and as they stand it would appear that the whole number of establishments in which cheese was made was greater in the year 1880. This is no doubt correct, as our cheese production reached its highest point in 1881.

One of the State dairy laws in 1885 authorized the State commissioner to issue a brand for New York State Full Cream Cheese, and fixed a heavy penalty for its use on any cheese that was not full cream. The factories did not take up the use of this brand very readily, apparently for the reason that many of them made skim cheese in the fall, and could not place the brand on this class of goods. Dealers, however, appreciated the value of the brand, and gradually came to make demands for it, so that in the year 1890 Commissioner Brown gave a list of 757 factories which had used it that season. In 1891 the number had risen to 796, but by 1894 it had decreased to 773. According to this latest enumeration, Cattaraugus County stands first, with 102 factories using the brand; Oneida County comes next, with 96, and Allegany third, with 91. Then follow, at a considerable distance behind, Lewis, with 69; Herkimer and Oswego each with 66, and Jefferson, with 63. Of the remaining cheese counties comparatively few use the brand.

SIZE OF FACTORIES.

There is a wide difference in the sizes of cheese factories. Some make only 5 or 6 cheeses a day; others make as many as 22 in the height of the season. A factory of average size will produce from 8 to 10 cheeses a day. Five cheeses a day would require about 3,000 pounds of milk. As a rule, the smallest factory would use the milk of about 150 cows; the average factory would take the milk of 300; while the largest would have the patronage of from 500 to 600. The number of patrons is so variable that it is impossible to give any idea concerning it that would be trustworthy. One farmer has 5 cows, while his neighbor may have 50. The larger dairies are more apt to go to the large factories, hence the number of patrons at a small factory is liable to be out of all proportion to the number contributing to a large factory. So the amount of cheese made in a cheddar factory ranges from 19,000 or 20,000 pounds in a season up to 220,000 pounds, or even more. An average factory will make from 36,000 to 40,000 pounds.

The location of patrons with regard to the distance from the factory varies from one-half mile to 3 miles. Generally they come within a radius of about 2½ miles. The milk has to be delivered at the factory by 8 a. m., or sometimes earlier, and it is hardly feasible to do the milking and haul the milk more than three miles before that time in the morning. It is sometimes delivered twice a day, at morning and at night, and this trouble of hauling is regarded as one of the main items in deciding upon the location of a factory. It makes but little difference in the expense, however, as the farmer usually drives the milk to the factory himself and uses his own horses to do the hauling.

SYSTEM OF MANAGEMENT.

There is practically no difference in the system of factory management at the present time.

Originally the milk received at the pioneer factory was wholly purchased by the manufacturers, it being estimated and paid for by the amount of curd it produced when pressed. This was not satisfactory, so dairymen were left to accept a price for their milk or curd which the manufacturers felt safe in offering, or to allow them $1 per hundredweight of cheese manufactured and the whey for performing the work of making, curing, preparing for market, selling the cheese, receiving and disbursing the money, the dairyman paying all other expenses, as boxes, bandages, salt, rennet, etc.[1]

Coming down to our own time, it is found that factory men receive $1 per hundredweight for making, as they did thirty years ago, but for that sum furnish all the extras which are enumerated above as being paid for by the dairymen. The factory may be owned by a single proprietor or by a stock company, but the system of management is the same in either case. Generally a settlement is made with the patrons once in two weeks. Few factories in New York have as yet adopted the method of paying on the basis of fat contained in the milk, consequently each man is credited with the total weight of milk he brings, an average is made each time of the amount of milk it takes to make one pound of cheese, and the patron is paid in accordance with this average on the basis of the price per pound of the two sales of cheese put together. The average factory season runs from April 1 to November 1. Some of the large establishments run three or four weeks later but these are exceptions. After the factory has closed dairymen use their milk to make the winter supply of butter for themselves and their neighbors.

There is little difference in the practice of factories as to the length of time allowed for curing their cheese. It ranges from eighteen to twenty-five days, according to the season of the year. In the spring, when makers are anxious to get rid of their fodder cheese and to take advantage of the market before prices decline, it is shipped at eighteen to twenty days from the hoop. Later in the year it is held longer, in order to cure it better and give it safer keeping qualities. It used to be the custom with some factory men to hold their cheese in the fall and again take advantage of the higher prices that are apt to prevail late in the season. This is still done to some extent, but so many factory men have lost money on their cheese in the last two or three years by trying this experiment that it is not now practiced to the same extent as formerly.

FROM FACTORY TO TABLE.

Now let us take a piece of cheese at the factory and follow it till it reaches the hands of the consumer. Suppose it sells at a board of trade for 6½ cents per pound. In a general way this may be calculated at 65 cents per 100 pounds of milk. In old times that amount of milk would make 10 pounds of cheese, although for a year past it has taken an average of about 105 pounds to make 10 pounds of cheese. This would deduct 1 cent per pound from the price obtained for the cheese as the cost of manufacturing, leaving 55 cents to the dairyman for his hundredweight of milk. The wholesale cheese business has always been a very close one, and considering the amount of money used in it during a year, the profits are probably smaller than in any other line of trade. The original buyer is very lucky if he gets a commission of one-eighth of a cent per pound. Freight from different points in the State to New York City varies somewhat with the distance, but an average of 25 cents per hundredweight will about cover it. This and the commission to buyer makes the cheese cost in New York City 6⅞ cents. The merchant in that city expects to make a profit of one-fourth to three-eighths of a cent if the goods are sold soon after their purchase. This brings the price up to 7¼ cents, which the retailer has to pay. Then comes the charge which does so much to hinder the consumption of cheese in this country. Retailers are not content to take a moderate profit, but must have from 50 to 75 per cent advance on the cost of the goods. The common price of cheese at a grocery store, when it costs the retailer from 7¼ to 7½ cents, is 14 cents per pound. In England, all through the season of 1895, cheese sold at 5d., or 10 cents, retail, and in 1896 it has sold there as low as 4½d., or 9 cents, per pound. When American grocerymen are willing to accept as moderate a profit on cheese as the English retailer, and sell it on the same plane as they sell butter, at an advance, say, of 20 to 25 per cent over cost, then we may expect to see the consumption largely increased; but so long as they persist in demanding such an enormous profit as they have done in the past, cheese will be looked upon as a luxury and only those will buy it who can afford to indulge in luxuries.

---

[1] Report of American Dairymen's Association for 1864, p. 49. Paper by George Williams, son of the founder of the factory system.

THE FUTURE OF THE AMERICAN CHEESE TRADE.

CAUSES OF DISCOURAGEMENT.

Canadian competition.—Certain features which militate against the cheese business in this country have already been mentioned, but there are others that may prove quite as serious. There is no doubt that Canada will continue to increase her make as long as she can find a market for the goods. If it were not for our duty on foreign cheese, the Canadian product would surely invade the States, for the reason that the dairymen of Canada live more economically than our dairymen and can afford to produce goods cheaper. Our duty on cheese protects us against this invasion, and the Canadians must therefore seek their markets in Great Britain and elsewhere. In order to do this most successfully, they are aware that their product must be hedged about with every restriction that will prove a guaranty of its genuineness. Their laws are framed with express reference to this guaranty, and the buyer is thus positively assured not only that Canadian cheese contains all the essential parts of the milk, but that it does not contain any foreign substance whatever. This legal requirement gives confidence in the cheese abroad and causes it to be sought in preference to stock from this country, of which so much has been adulterated that it is all looked upon with suspicion. One State has one law on the subject and another State has another law, while still another has none at all. It has become self-evident that we must have a national law which will affect the whole cheese product alike, and it will place it on the same footing with that of our Canadian neighbors. With such a law in existence, it will be the fault of our dairymen and cheese makers themselves if their product does not meet with as ready sale as that of the Provinces. It is true that Canada has fostered this industry by large grants of money and by the creation of a department whose special business it is to see that every cheese maker in the Dominion is well instructed before he begins his work, and that he receives additional instruction each year to enable him to keep up with the march of improvement. In our country the States in which cheese is made have many other ways of using their money, and unfortunately too often prefer to appropriate it for purposes dictated by political partisanship. As a consequence, the majority of our cheese makers are too apt to go on in their old and often careless methods, with no one to instruct them or to suggest a better method. The exception to this is found in the case of "combinations" of factories. Here a number of factories are brought under the control of one man, the proprietor or a superintendent. He says to his makers, "I want all of our cheese to be uniform in quality, and in order to have them so they must all be made by the same rule and on the same plan. None of you can exercise independent judgment in this matter, but all must conform strictly to the instructions laid down by the company." By this means the combination avoids the rock upon which too many of the separate factories go to pieces. That rock is the idea of the maker that he knows as much as anyone else on the subject of cheese making and his unwillingness to try to learn even when he has the chance. Canada is one big combination under the direction of its thoroughly capable dairy commissioner. He lays down the rules and all the factories follow them; hence the excellence and uniformity of Canadian cheese.

Australasian competition.—But Canada is not our only competitor. For a number of years New Zealand has shipped a considerable amount of cheese to England, although it is understood that her product is not equal in quality to that of either Canada or the United States. In 1894, however, a more successful rival appeared in the shipments from Australia. For several seasons down to 1892 the Victoria government had paid a bounty to butter makers who exported their butter to the mother country, and having placed that industry on its feet, the government withdrew the bounty. Then a few cheese factories were established in the colony, and in 1894 a bounty of 6s. per hundredweight was placed on all cheese manufactured in the colony which could be proved to have brought the producer or exporter more than 50s. per hundredweight. In the spring of 1894 the first shipment of these goods arrived in London, consisting of 1,430 cases, 2 cheese in a case. These sold at 55 to 60s., at a time when Americans were selling at 59s. for the best, thus showing that the quality was quite equal to our own. The American was of course old cheese at that time of the year, while the Victorian cheese was newer by several months, and in reality the former ought to have brought the best price in order to put the two on a par at the same age. Again last year Victorian stock was in evidence, but very little of it could have received the bounty, as American sold early in the season at 48s. and for a long time in the summer stood at 37s. 6d. to 38s. 6d., and Australian would probably command not much better prices. At the same time cheese can be produced in Victoria much cheaper than in this country. The climate is so mild that the farmers are not obliged to build cattle barns, but allow the cows to remain out the whole season and milk them for nine or ten months. In the early months of 1895 they received about 60 cents per 100 pounds for their milk, and it was said that under their favorable conditions they could produce it at 50 cents or less and still get a fair living out of the business. This is more than can be said of our own dairymen, who complain loudly if they are obliged to accept 60 cents, and who probably could not afford to produce it for that price under the present conditions of living. Australia and New Zealand sent upward of 4,000 tons of cheese to England in the early season of 1895, and they will probably continue to send increasing quantities in the present and subsequent years. This competition must therefore be met on an equal basis if we expect to continue sending cheese abroad.

The lessened exports.—The receipts of cheese at New York and the exports from that port tell the story of diminution in foreign demand. In 1890 the exports were 65 per cent of the receipts; in 1891 they were 63 per cent; in 1892, 67 per cent; in 1893, 60 per cent; in 1894, 67½ per cent, and in 1895, only 43 per cent. The prices in New York on May 1 in each of these years were as follows: In 1890, 11¼ cents; in 1892, 10 cents; in 1893, 11 cents; in 1894, 10¾ cents; in 1895, 8 cents. The average price for the season on the Utica Board of Trade, which is the largest cheese market in the interior of the country, was as follows: 1890, 0.0842; 1891, 0.0888; 1892, 0.0933; 1893, 0.09647; 1894, 0.09465; 1895, 0.07648; and all this is in the face of a severely diminished production. Is it any wonder that our dairymen feel like throwing up the business and engaging in some other branch of agriculture? Is it not natural that they should ask, Where is our cheese to be marketed and what will be its price?

Weighed down by these unfavorable circumstances, as well as by the faulty manufacture of much of our own cheese and by the counterfeit stock that has flooded the foreign and Southern markets, is it any wonder that our dairymen feel disheartened at the enormous decrease in the volume of exports?

Filled cheese.—Within the last two or three years immense quantities of filled cheese have been shipped into nonproducing States, most of it with the label of "Full-cream cheese," but at prices just enough below those of the genuine article to insure it a rapid sale. Quality being equally good, or, what is nearly the same thing until the facts are found out, appearances being equally good, the buyer will take those goods on which he can make the most money. And the filled-cheese makers have been exceedingly wise in their day and generation. They have studied carefully every point that would help the sale of their product. Their cheese are well boxed; they have perfectly level, smooth surfaces on top and bottom, with square and even edges; they are bright and handsome in color; they are made solid, and show good body under the trier. In all these respects filled-cheese makers set a good example to the makers of real cheese. They known that appearance has great influence in the sale of any kind of goods, and they have therefore made an exhaustive study of appearance, which it would be for the interest of makers of full cream cheese to imitate. But the crime of the filled-cheese men, for it is nothing less than a crime to destroy by unfair means a legitimate industry upon which hundreds of thousands of people depend for their support, is that they put their product on the market under a false name and sell it not for what it is but for what it is not. No fair-minded man would complain if filled cheese was branded with its real name and sold as such; but when it is branded as full cream cheese and used to fill contracts for that class of goods, every fair-minded man will declare that the law must step in to prevent such deception. At all events, it is the practice of this deception which has wrought such havoc with the trade in full cream cheese at the South and in far Western States. The imitation goods have taken the place of the genuine by means of assuming the name of the genuine and by being sold at a lower price. Thus the genuine has been crowded out of market even in a season of such light production as that of 1895.[1]

The new law.—In the State of New York existing laws still further aggravate the situation by forbidding the saloons to offer free lunches, thus closing one of the largest agencies for the consumption of cheese. It is estimated that the saloons of Greater New York used from 8,000,000 to 12,000,000 pounds of cheese per year; and if those of the rest of the State be added to this it would bring the total consumption by means of free lunches up to at least 15,000,000 pounds, or about one-sixth of the total production of the State last year. This law is one of the severest blows yet inflicted on the cheese industry. Whether it will be permanent remains open to question. A repeal of this clause in the present law is not improbable, but it must stand during the year 1896 at least.

SOME GROUNDS FOR ENCOURAGEMENT.

And yet, with all these discouragements, the situation is far from being devoid of hopeful aspects. The question naturally arises, What must our dairymen and cheese factory men do to improve the conditions surrounding their industry? The first and most obvious thing to be done is to make better cheese, cheese which when brought into competition with the foreign will possess just as fine flavor and just as long-keeping qualities as that product. This is one of the self-evident propositions which it hardly seems necessary to spend any time in discussing. It is, however, a vital point, and must be looked after with all the ability, shrewdness, and skill that our makers can bring to bear upon it. With an equally fine quality of cheese, we can hope to compete with Canada in the markets of the Old World; without this quality, we shall eventually have to give up those markets altogether.

---

[1] It should be noted that this report was mainly prepared before the passage by Congress of the act approved June 6, 1896, requiring distinct branding of all filled cheese and placing special taxes upon its manufacture and sale.

In the next place, our merchants must struggle to retain the markets of the South and West. The national law in the interests of pure food, which compels "filled" cheese to be plainly branded, will oblige the makers of that article to sell it on its merits only. This will necessitate their selling it at a much lower price if it is sold at all, and will destroy its rivalry with full cream cheese, under the name of which it has heretofore been marketed. The enforcement of this law ought to go a long way toward restoring the trade in genuine cheese throughout the South, which was almost ruined in the year 1895 by the sale of the counterfeit goods. The restoration of this class of home trade will materially help our cheese industry, particularly those establishments that make cheese weighing from 34 to 40 pounds.

A third suggestion for relieving cheese dairymen is that a portion of them should follow out the line hinted at on page 29. If the manufacture of cheese was more diversified, if a greater number of varieties were made, instead of confining the manufacture so largely to Cheddar cheese, there would be profit in it for those who made the varieties and relief for those who did not adopt that course. In the reports of fancy cheese factories it has been seen that the prices of their products were but little affected by the decline in Cheddar cheese. It may be said that this is because there are comparatively so few of them and the competition is so limited. There is probably some truth in this view of the matter, but it is also true that a choice, palatable article will always find a good market. The amount of fancy cheese sold shows that a fine, small sized cheese is in demand, and these goods bring considerably higher prices than ordinary cheese. Most of it is so made that it possesses long-keeping quality, which is always an advantage, both to the maker and the merchant who deals in it. Besides, there is still room for other varieties, as it has been shown that considerable cheese is imported from foreign countries which might be made in this country, providing the requisite care and skill were exercised. The population of the United States is increasing with much greater rapidity than its dairy interests, and down to the time when filled cheese began to make such inroads upon the home trade the surplus cheese left by the gradual diminution of our foreign trade was being fairly well consumed by our own people. Even with the enormous shrinkage in our exports last year (1895), which was much heavier than the shrinkage in our manufacture, the stocks of old cheese on hand in our markets in the spring of 1896 were smaller than they were a year before; it is a fair inference that, if our markets are not handicapped by filled cheese, the home consumption will be able to take care of a larger surplus than we had last year. With proper laws to protect the cheese industry against frauds, with greater variety in the styles of cheese made, and with an improvement in the quality of our goods, there is no good reason why our cheese dairies should not become as prosperous as they were before the disastrous season of 1895.

FACTORY CHEESE AND HOW IT IS MADE.

By G. **Merry**,[1] *of Verona, N. Y.*

MODERN METHODS PRACTICED IN THE UNITED STATES.

The successful cheese maker considers good milk of paramount importance. For this he must depend upon the producers and his own watchfulness.

Handling milk.—The first step in the process of making cheese—the care and handling of the milk—devolves upon the farmer. If up to date, he must have a good herd of cows, treat them kindly, and provide them with plenty of clean, wholesome food and pure water. As the quality of milk depends much upon the management of the cow, pure milk may be expected from a well-cared-for dairy. After the milking is completed, the milk should be immediately taken from the stable and well aërated, or brought in contact with the air, either by running thinly over a flat or fluted surface, or passing from one vessel to another in fine streams or thin sheets. Milk should be aërated in a place where the air is fresh and pure, being free from stable or other objectionable odors. As the object is to remove the so-called animal odors from the milk, it would be useless to perform the work in an atmosphere laden with the same or worse smells than it is desired to expel. When delivery to the factory is but once a day, the night's milk, after being aërated, is cooled to 70° F. or less; this is necessary to insure the keeping quality of the milk and its arrival at the factory in good condition.

All cans, pails, strainers, and whatever utensils come in contact with the milk must be thoroughly washed with the aid of some cleanser, such as soap or salt, rinsed with boiling water or exposed to live steam, and placed where they will be thoroughly aired. By this means they are kept sweet and free from taint.

The milk is all delivered at the factory in the morning between the hours of 5 and 8 o'clock. The night and morning's milk should be brought separately, although it is sometimes mixed where the quantity supplied by a patron is small. The cheese maker knows it is his duty to receive no milk unless in proper condition. He stands at the receiving window, and by the use of his eyes and nose is able to detect any impure milk; all such must be absolutely rejected. He must have the experience and force of character to impartially perform this duty.

---

[1] Mr. Merry is a practical cheese maker operating a factory at Verona, and has repeatedly won high prizes for his work. He has prepared this chapter by special request.

Upon the milk being accepted, it is poured into the receiving can, and a small sample is taken at this time for the fat test to be made later.

Sampling milk.—For sampling, a deep cylindrical cup holding about 1 ounce is used. This sample of milk is poured into a bottle large enough to hold 12 or 14 times such samples and bearing the number of the patron whose delivery of milk is sampled. One such bottle or jar is provided for every patron. A sample of each patron's milk is put into the proper bottle every day for ten days or more, and from this composite sample, as it is called, the test is made by the Babcock method of the fat contained in this patron's milk. A small amount of corrosive sublimate,[1]—about as much as can be taken on the point of a common penknife—is put into the bottle previous to saving the first sample; this prevents the milk from souring and preserves it in a suitable condition for testing. After sampling, the milk is weighed and the patron credited with the number of pounds of milk he delivers. The milk is then run from the receiving can through a tin conductor into the storage vats. Each vat ordinarily holds about 5,000 pounds of milk.

Heating milk.—The temperature of the milk is then raised, heat being applied as follows: Between the wooden part of the vat and the tin lining there is an open space, which is filled with water; the water is heated by steam introduced through perforated pipes running in this space along the whole length of the vat. The warm water thus surrounding the tin lining of the vat gradually raises the temperature of the milk. The heating should begin while the vat is filling or as soon as filled, and should not be done too fast. After the required temperature of 82° F. to 86° F. is reached, the heating is stopped. The heating of the first vat usually begins at 6 o'clock or soon after, and all milk should arrive so the heating of the last lot may begin not later than 8 o'clock.

Determining ripeness.—The next step is to ascertain if the milk is in a condition ripe enough to add the rennet. Perhaps the most satisfactory method to determine the ripeness of the milk is the rennet test. The following specially prepared apparatus is necessary: An enameled cup, graduated on the inside, with a fine hole in the bottom, a pipette of 1 cubic centimeter, and a small bottle marked on the neck. With the pipette 1 cubic centimeter of rennet extract is measured into this bottle, which is then filled with water to the mark on the neck, not forgetting to rinse the pipette into the bottle. If the extract used be of standard strength, this will give a uniform solution at all times. The cup is then filled with milk and set on the edge of the vat. When enough milk has run from the cup to bring the surface of the milk down to the zero or first mark on the inside, the diluted rennet is quickly added, the whole stirred well, and the cup left undisturbed. The milk in the cup is closely watched, and as soon as coagulation takes place it will stop running through the fine hole in the bottom of the cup. The graduation on the inside of the cup will show the amount of milk which has run out, and from this the maker knows the degree of ripeness which the milk has attained. This little operation requires some skill and experience.[1] The temperature of the milk and the strength of the rennet being always uniform, the variation in the amount of milk running from the cup before coagulation takes place will depend solely upon the degree of acidity of the milk.

---

[1] Other substances, among them bichromate of potash and formaldehyde, having a similar effect, are also used as preservatives.

When the milk is very sweet the ripening process is hastened by using a small quantity of clean sour milk, free from any taint. If this milk is thick, it is strained through a cloth so there will be no little lumps of loppered milk put into the vat. The milk should be so ripened that it will take from three and one-half to four hours from the time the rennet is added until the curd is ready to press. The degree of ripeness necessary to accomplish this result is only to be determined by experiment on the part of the maker. The condition of milk and degree of ripeness necessary will vary somewhat in different factories, and the cheese maker has to use his judgment at such times. When cheese is to be colored the coloring extract is put into the milk in the vat and well mixed in at least ten minutes before adding the rennet.

Handling the curd.—When, in the judgment of the maker, the milk is ready to proceed, sufficient rennet is added to coagulate the mass in about 30 minutes. The curd being set, it is ready to cut when it will break clean over the finger. For cutting the curd two forms of gang knives are used, a horizontal and a perpendicular knife, with blades about one-third to one-half inch apart. The curd is cut lengthwise and crosswise of the vat with each knife. This amount of cutting leaves the curd in cubes of about one-third of an inch on a side. The degree of fineness into which the curd must be cut depends on the ripeness of the milk, and is a matter which must be determined by the manner in which the moisture is expelled from the curd before the whey is drawn. It is usually about an hour and a half from the time heat is applied to the vat until the curd is cut. After cutting, the curd is gently agitated, to prevent it from settling to the bottom of the vat and matting together. The stirring allows the curd to shrink and expel the whey, or a portion of it. The kernel or small cube or lump of curd forms a thin skin or film over its surface, which prevents the fat globules and other cheese constituents from working out into the whey. The stirring of the curd after it is cut may be done by a hand tool called the curd rake. But a better factory appliance for this purpose is the "automatic curd agitator," which is attached to the vat and operated by steam. There are at least three different patterns of these agitators which do the work more satisfactorily than the hand rake. After stirring the curd for about ten minutes heat is applied again to the vat through its water jacket, slowly at first, as if heated too fast the pieces of curd would cook on the outside and thus hold in the whey. After a temperature of about 92° F. is secured the curd is heated faster until the required temperature of 97° to 100° F. is reached. This process, which is often called "cooking the curd," usually takes about one hour's time. During the heating process the curd is continually stirred and not allowed to get lumpy or to mat in the least. All the kernels must be kept separate to insure an even cooking. After the required temperature is reached the curd is still agitated for a few moments. The vat is then covered to assist in holding the curd at an even temperature until ready to draw the whey. If the heat drops it is again raised to the original temperature. It is important to know when the curd is cooked enough. This the cheese maker determines by taking a double handful and pressing together in his hands. If on removing one hand the curd readily falls apart it is cooked enough, otherwise it will be soft and hang together in a ball. When the curd will string about one-fourth to one-third of an inch on the hot iron the whey is drawn. The time occupied from the beginning of the cooking until the whey is drawn varies from two to four hours, averaging two and one-half to three hours.

---

[1] This is known as the Marschall test, the simple apparatus being sold by dairy-supply houses.

In using the hot-iron test a small amount of curd is compressed in the hand until dry. This, when touched to a hot iron and slowly drawn away, will leave fine silky threads sticking to the iron if any acid has developed. The amount of acid is determined by the length of these strings. Any piece of bright, clean iron one-half inch in diameter and about 18 inches long will answer for this purpose.

After drawing the whey the curd is stirred somewhat and thrown up on each side of the vat. The vat is lowered at one end to make an incline to allow the whey to drain away from the curd. As the whey passes off and the curd becomes dry it becomes matted together and is then cut in pieces about 6 inches square and piled one on top of the other in one end of the vat. The curd is now turned as often as once in ten or fifteen minutes and piled in larger piles as fast as it will allow, always keeping in mind the fact that the surplus moisture must be expelled if we wish to make a good-keeping cheese. If curd is in a good condition it is kept warm by covering with a cloth and repiled occasionally. The curd soon becomes firm, and when a piece is taken in the hand it will feel velvety and pull apart in flakes. At this stage the curd will pull from three-fourths to 1½ inches on the hot iron. The curd is now ground and salted, using from 2 to 2¾ pounds of salt to 1,000 pounds of milk. The salt is well stirred in and curd allowed to lie in the vat, with an occasional stirring, until salt is all dissolved and curd feels smooth and silky; it is then ready to press. The average time occupied from drawing the whey to this point is two hours, and from first heating the milk to the beginning of pressing the time is from five to six hours.

There are several kinds of mills for grinding curd. The one most commonly used consists of two cylinders covered with teeth and revolving toward each other, which pick the curd to pieces. The mill fits across the vat and the curd is ground through it into the vat.

The curd when ready for pressing is dipped from the vat with a flat-sided curd pail and put in the hoops, an equal amount being measured into each hoop. The hoops are immediately placed in the press and pressure applied.

There are several kinds of hoops, the most common sizes being the 14½ by 10 inch and the 13½ by 6 inch—that is, the hoops press cheese of those sizes. The bandage is put on an iron rim called a bandager, which slips into the top of the hoop and holds the bandage in place, with the lower edge of bandage turned in for about an inch on the bottom of the hoop, a cap cloth being first put in the bottom of the hoop.

There are times during the season, usually in the summer months, when curds have a tendency to be mushy, and will not become firm if piled. These curds are handled differently, being left in the whey longer—in fact as long as the maker deems it safe. The whey is then drawn and curd stirred thoroughly until it feels dry. It is then spread out over the vat, kept cool, and handled often in order to expel the moisture. When the curd becomes firm it is ground and salted, the salt thoroughly stirred in and the curd put in hoops and pressed at once. These curds if allowed to get mushy will make what is known as an oily cheese. The cause of this is found to be due mainly to a lack of the proper proportion of casein in the milk.

Pressing and curing.—The pressing of the cheese is done lightly at first and afterwards the pressure is gradually increased. After pressing about an hour the cheese is taken out and turned over in the hoops, the bandage carefully turned down and cap cloth put on smoothly. Pressure is then applied stronger and oftener until the limit of the press is reached. The cheeses are kept under the pressure for sixteen or eighteen hours, when they are taken out of the hoop and placed in the curing room. The cap cloths are left on the cheeses until they are ready for market.

The curing room is built with a wind-proof wall to guard against sudden changes in temperature, and provided with tight windows and blinds. The room is kept as nearly as possible at a temperature of 65° to 70° F., and should be well ventilated, so that the cheese may cure properly and have a clean flavor. The room should have tables, upon which the cheeses are turned and wiped. The cheeses, after being placed in the curing room, are turned over every morning and kept clean and free from mold and dirt; the tables are also wiped clean, using some canvas cloth for this purpose. The curing room is darkened during the day to keep it free from flies; in warm weather the windows and blinds are closed in the daytime to exclude the heat, and thrown open at night to cool the room. The cheeses remain in the curing room on an average of three to four weeks. The conditions governing this variation in length of time are due to the differences in the manufacture of the cheese, temperature of curing room, and the state of the cheese market.

When ready for market, the cap cloths are removed from the cheeses and they are boxed; a scale board is placed in the bottom of each box and one on top of each cheese put in the box. The boxes are evenly trimmed to within one-eighth to one-fourth of an inch of the top of the cheees and the cover put on. The official State brand is put on the top of both the cheese and the box, and the manufacturer's or factory brand is also usually put on the box.

The foregoing is a description of the latest improved methods practiced in factories in the State of New York, where cheese of the usual 60-pound Cheddar form and style is made, principally for export.

Cheese for home trade is made in the same way, except that the whey is drawn off as soon as the curd shows any acid by the hot-iron test. The curds are well matured in the vat and salted with about 2 pounds of salt for every 1,000 pounds of milk.

METHOD OF APPORTIONING DIVIDENDS UPON THE FAT-TEST BASIS.

The custom as to time of settlement for milk supplied by patrons varies somewhat with different factories. In most cases computations are made and settlements reached every two weeks, although some use monthly periods. Each settlement is made for a definite period of manufacture, and after the cheese made in that period has been cured, shipped, sold, and paid for.

The quantity of milk which each patron has delivered during the time included in any settlement is taken from the daily records. The test records for the same period give the average per cent of fat which the milk contained during the time, ascertained from fat tests of the composite samples. The total quantity of milk delivered, multiplied by the average per cent of fat, gives the number of pounds of fat delivered by the patron during the period considered. This is the basis for settlement. From the gross receipts for cheese sold for the period the expense of manufacturing is deducted and the net proceeds of sales are divided by the total number of pounds of fat delivered by all the patrons during that period; the quotient is the net amount for each pound of milk fat which has been realized by the sales of cheese. Each patron is to be paid at this rate for the number of pounds of fat contained in the milk furnished by him.

For illustration, take the examples following, to cover a period of one month: A delivers during the first ten days of the month 1,500 pounds of milk testing 3.2 per cent of fat; during the next ten days 1,700 pounds testing 3 per cent, and during the last ten days 1,600 pounds testing 3.1 per cent. B delivers during the first ten days 2,500 pounds of milk testing 3.6 per cent; the next ten days 2,700 pounds testing 3.5 per cent, and the last ten days 2,800 pounds testing 3.7 per cent. C delivers 2,000 pounds testing 4 per cent the first ten days; 2,200 pounds testing 4.1 per cent the next ten days, and 2,400 pounds testing 4.2 per cent the last ten days. We find the total of milk delivered by all to be 19,400 pounds; total number of pounds of fat, 707.7. Supposing that from this milk 1,940 pounds of cheese was made, selling at 10 cents per pound, the following figures will be found upon the record books of the factory:

Gross receipts, 1,940 pounds of cheese, at 10 cents	$194.00
Deduct cost of making and furnishing cheese at $1 per hundredweight	19.40
Net proceeds to be paid to patrons	174.60
$174.60 divided by 707.7, the total pounds of fat, gives the net price per pound of fat to patrons as	$0.24671+
Average per cent of fat in all milks	3.64+
Number of pounds of milk to 1 pound of cheese	10

Settlements with individual patrons:

	Milk.	Fat.		Payment or dividend.
	Pounds.	*Per cent.*	*Pounds.*	
A:				
First 10 days	1,500	3.2	48	
Next 10 days	1,700	3	51	
Last 10 days	1,600	3.1	49.60	
	4,800		148.60, at $0.24671	$36.66
B:				
First 10 days	2,500	3.6	90	
Next 10 days	2,700	3.5	94.50	
Last 10 days	2,800	3.7	103.60	
	8,000		288.10, at .24671	71.08
C:				
First 10 days	2,000	4	.80	
Next 10 days	2,200	4.1	90.20	
Last 10 days	2,400	4.2	100.80	
	6,600		271, at .24671	66.86
Total				174.60

A statement similar to the following is given monthly to every patron:

September dividend, 1895.

Mr. ——— A———:

Number of pounds of milk received from your dairy during the above-named month, given in separate amounts, with per cent of fat in each, as shown by the Babcock test:	1,500 pounds, 3.2 per cent fat. 1,700 pounds, 3.0 per cent fat. 1,600 pounds, 3.1 per cent fat. ———
Total	Milk, 4,800 pounds; fat, 148.60 pounds.
Average per cent of fat in all milks delivered at the factory during said month ... per cent	3.64+
Amount of milk required to make 1 pound of cured cheese during said month ... pounds	10
Average price per pound received for the cheese made during said month	$0.10
Net price per pound of fat	$0.24671
Amount of cash now paid to you, being in full for the milk delivered by you during said month, after deducting my charge of $1 per 100 pounds for making the cheese and furnishing materials	$36.66

By this statement the patron can see how much he has delivered during each period covered by the sales, and the testing, and the per cent of fat in his milk during that period. He can also compare the per cent of fat in his milk with the average of all milks delivered at the factory during the month.

In changing from the old method of paying for all milk alike by its weight to the fat basis, the question was brought before our patrons at their regular annual meeting and thoroughly explained. The patrons had been informed some little time previous to the meeting of the intention of taking some action in the matter, and several of them had given thought and study to the new method and were prepared to discuss the question intelligently. After a thorough exchange of opinions a majority were in favor of adopting the new method.

During the first year of using the test the patrons made little objection to its use, preferring to give it a fair trial and note the effects. The conclusion reached by the patrons after this trial was clearly shown at the next annual meeting, when, with but a single objection, it was voted to continue the test method. At the present writing, after three years' practical use of the Babcock test, the patrons would not consent to a return to the old method.

The introduction of the fat basis has resulted in a general improvement of the interests of our factory and the patrons. The quality of the milk being an important factor in determining its value has led to a more systematic method of breeding. Almost every dairyman and patron is giving more thought to the principles governing breeding and is endeavoring to produce a herd giving a large amount of milk of the best quality. He also feels more interest in his work and consequently his milk is better cared for and delivered at the factory in better condition. The cheese maker is thus enabled to produce a finer quality of cheese and also to show an increase in the amount of cheese manufactured from every 100 pounds of milk.

This basis of settlement is certainly far more equitable as well as better, because of the results stated, than the one so long in use and still adhered to by many factories. Canadian authorities now claim, however, that it is not quite fair to depend upon the fat content of the milk alone, but that the casein should also be taken into consideration. More time and experience is necessary to consider this proposition for a further change in the basis of settlement with patrons.

APPENDIX.

TABLES OF CHEESE PRODUCTION AND TRAFFIC.

No trustworthy record of receipts in the city of New York were made previous to 1865. Down to 1878 the record runs from January to January; but from May 1, 1877, the record began to be compiled from the opening of a new season in the receipt of goods, and Table No. I., is arranged accordingly.

TABLE NO. I.—*New York receipts of butter and cheese (in packages).*

Year.	Butter.	Cheese.	Year.	Butter.	Cheese.
1865	607,136	....	1880	1,494,015	2,833,678
1866	493,061	742,441	1881	1,423,717	2,830,586
1867	551,791	1,302,132	1882	1,386,672	2,286,396
1868	502,906	1,136,584	1883	1,517,818	2,486,612
1869	645,195	1,335,522	1884	1,618,270	2,441,561
1870	552,973	1,495,969	1885	1,633,652	2,091,862
1871	480,767	1,331,250	1886	1,661,916	1,861,457
1872	473,351	1,542,972	1887	1,690,447	2,070,379
1873	689,761	1,809,689	1888	1,774,374	1,950,176
1874	995,430	2,036,468	1889	2,092,115	1,953,522
1875	1,080,899	2,322,331	1890	1,843,702	1,954,448
1876	1,292,577	2,171,617	1891	1,780,826	1,832,572
1877	1,269,759	2,420,601	1892	1,654,198	1,999,029
May 1, 1877, to May 1, 1878.	1,282,902	2,562,053	1893	1,711,466	1,551,468
1878	1,486,475	2,309,168	1894	1,708,576	1,613,385
1879	1,508,859	2,437,688	1895	1,923,061	1,259,990

TABLE NO. II.—*Transactions of the Utica Board of Trade.*

Year.	Number of boxes.	Value.	Average price per pound.	Range of prices.	Year.	Number of boxes.	Value.	Average price per pound.	Range of prices.
			Cents.	*Cents.*				*Cents.*	*Cents.*
1871	45,000	....	....	....	1884	315,641	$1,988,538	10.5	8 to 12⅞
1872	75,000	....	....	....	1885	320,796	1,531,159	7.955	5 10⅞
1873	100,000	$1,496,965	....	....	1586	325,962	1,773,885	9.07	6¼ 12¾
1874	154,800	1,777,692	....	11¼ to 16¾	1887	387,485	2,415,581	10.35	7¾ 12⅛
1875	160,820	1,735,592	12.5	10¼ 15⅞	1888	409,564	2,187,071	8.9	7⅞ 10¾
1876	167,355	1,077,431	11.1	8¾ 14	1889	441,386	2,294,500	8.664	7¼ 10⅝
1877	210,713	1,425,877	11.67	8⅛ 15	1890	385,631	1,948,207	8.42	6⅞ 10¼
1878	322,535	....	....	6¾ 12¾	1891	373,484	1,889,656	8.85	7 11¾
1879	301,559	1,488,555	8.227	8 13¼	1892	248,470	1,390,935	9.63	8¼ 10¾
1880	298,827	2,085,573	11.632	6⅛ 14¾	1893	217,768	1,260,484	9.647	8⅛ 12⅛
1881	240,746	1,615,184	11.1818	8⅛ 13⅝	1894	273,896	1,555,455	9.465	7¾ 11¾
1882	220,502	1,523,593	11.5161	10 13	1895	218,545	1,002,859	7.648	5 10¾
1883	264,628	2,025,291	10.8437	8 13½	1896	190,038	895,649	7.855	5¼ 10

TABLE NO. III.—*Transactions of the Little Falls Board of Trade.*

Year.	Number of boxes.	Value.	Average price per pound.	Range of prices.	Year.	Number of boxes.	Value.	Average price per pound.	Range of prices.
			Cents.	*Cents.*				*Cents.*	*Cents.*
1875	158,232	....	12.5	10½ to 16	1886	209,135	$1,139,367	9.08	6 to 12½
1876	177,273	....	10.83	7 14	1887	229,017	1,514,106	10.36	7 13
1877	222,847	$1,547,204	11.819	9 14¾	1888	239,085	1,245,093	8.95	7¼ 11
1878	281,618	....	....	6½ 12⅛	1889	265,224	1,337,776	8.7	7⅛ 10⅛
1879	244,943	1,149,566	7.822	4 13¼	1890	245,059	1,181,836	8.36	6¾ 10⅛
1880	248,704	1,714,863	11.492	6½ 14½	1891	236,249	1,202,788	8.55	7⅛ 11
1881	253,025	1,653,766	10.893	7 13	1892	206,058	1,218,662	9.15	7 10¾
1882	213,175	1,468,836	11.484	9 12¾	1893	197,865	1,106,337	9.5	8 11¼
1883	244,102	1,581,989	10.797	8 13¼	1894	202,028	1,088,474	9.096	7½ 11
1884	226,196	1,407,391	10.37	7 13	1895	150,207	714,684	7.93	6 10
1885	208,067	999,606	7.935	5¾ 10⅜	1896	120,754	564,259	7.788	6 9¾

TABLE NO. IV.—*Transactions of Watertown Board of Trade.*

Year.	Number of boxes.	Average price per pound.	Year.	Number of boxes.	Average price per pound.
		Cents.			*Cents.*
1879	50, 813	7. 195	1886	57, 462	9. 08
1880	60, 291	11	1887	42, 376	9. 63
1881	55, 961	9	1888	53, 331	9. 23
1882	56, 807	10. 08	1889	93, 778	8. 82
1883	65, 201	10. 288	1890	106, 068	8. 4
1884	94, 373	9. 09	1894	91, 207	9. 26
1885	47, 983	7. 75	1895	98, 845	....

TABLE NO. V.—*Production of cheese in New York State by counties (in pounds).*

County.	1845.	1850.	1855.	1860.	1865.	1870.	1893.	1894.
Allegany	....	1, 145, 391	1, 044, 978	939, 115	104, 374	220, 880	8, 548, 800	6, 914, 154
Cattaraugus	....	1, 382, 963	1, 717, 484	1, 857, 349	....	889, 132	13, 202, 919	11, 330, 154
Chautauqua	....	2, 271, 890	1, 198, 361	1, 153, 257	782, 257	778, 830	3, 201, 027	2, 669, 873
Chenango	....	1, 069, 331	1, 212, 544	1, 446, 538	1, 879, 363	280, 114	3, 999, 432	5, 212, 631
Erie	....	4, 243, 949	2, 038, 392	2, 278, 276	435, 774	503, 073	4, 958, 412	3, 907, 513
Herkimer	8, 208, 796	9, 548, 009	9, 068, 519	10, 901, 522	3, 526, 268	5, 101, 654	12, 364, 012	10, 978, 660
Jefferson	2, 802, 314	4, 192, 719	2, 819, 459	4, 773, 109	3, 357, 546	2, 545, 654	12, 061, 638	9, 962, 527
Lewis	....	3, 067, 300	1, 896, 741	2, 911, 775	3, 171, 721	977, 547	8, 694, 944	8, 853, 399
Madison	....	....	2, 087, 594	2, 589, 992	3, 462, 057	280, 776	4, 833, 000	4, 865, 434
Oneida	3, 277, 750	5, 218, 734	3, 811, 114	3, 519, 732	8, 107, 018	1, 228, 459	13, 067, 442	11, 794, 297
Oswego	....	1, 340, 545	975, 461	1, 108, 456	1, 460, 182	1, 089, 228	7, 034, 709	6, 613, 974
Otsego	....	2, 049, 673	1, 638, 493	2, 161, 929	1, 559, 591	829, 439	7, 094, 850	6, 109, 465
St. Lawrence	1, 281, 972	1, 596, 456	1, 672, 999	2, 353, 887	322, 615	1, 710, 082	14, 730, 278	11, 502, 880
Wyoming	....	1, 007, 359	823, 105	981, 946	446, 011	709, 935	5, 148, 340	3, 605, 072

NOTES.—The figures for 1865 represent only the cheese made in factories.
The figures for 1870 represent only the cheese made in private dairies.
According to the latest statistics these counties rank in the following order in regard to production: 1, Oneida; 2, St. Lawrence; 3, Cattaraugus; 4, Herkimer; 5, Jefferson; 6, Lewis; 7, Allegany; 8, Oswego; 9, Otsego; 10, Chenango; 11, Madison; 12, Erie; 13, Wyoming; 14, Chautauqua.

BULLETIN NO. 16. **(Dairy No 7.)**

U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF ANIMAL INDUSTRY.

THE DAIRY INDUSTRY

IN

NEBRASKA, SOUTH DAKOTA, AND NORTH DAKOTA.

BY

JOHN H. MONRAD,

SPECIAL EXPERT AGENT, DAIRY DIVISION.

Under the direction of

Dr. D. E. SALMON,

Chief of the Bureau of Animal Industry.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1896.

LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY,
Washington, D. C., October 27, 1896.

SIR: I have the honor to transmit herewith a report upon the dairy industry in Nebraska, South Dakota, and North Dakota, prepared under the direction of Henry E. Alvord, Chief of the Dairy Division of this Bureau, and based upon reports by John H. Monrad, special expert agent of that Division, and to recommend its publication as a bulletin of this Bureau.

Very respectfully,

D. E. SALMON,
Chief of Bureau.

Hon. J. STERLING MORTON,
Secretary of Agriculture.

CONTENTS.

Page.
Historical 7
Farm dairying and creamery patrons 9
    In Nebraska 9
    In South Dakota 11
    In North Dakota 12
Ladled butter 13
Creameries 16
Cheese factories 20
Extent and value of dairy interests 20
General remarks 21

THE DAIRY INDUSTRY IN NEBRASKA, SOUTH DAKOTA, AND NORTH DAKOTA.

HISTORICAL.

The dairy industry in the States of Nebraska, South Dakota, and North Dakota is in a comparatively new and formative condition, as are large portions of the States themselves. But agencies have already been created for assisting in the development and improvement of dairying. Each of these three States has its organization for joint effort by those engaged in this branch of farming.

The Nebraska Dairymen's Association resulted from the enterprise of a few men, and started in the year 1885 with J. Dixon Avery as president and H. H. Wing as secretary. (The latter is now at the head of the dairy department of Cornell University.) This association held its eleventh annual convention at Lincoln in December, 1895. It is generally considered that the work of the organization has been effective and has decidedly raised the average quality of Nebraska butter. The State has recognized this usefulness by appropriating $1,000 a year for the association, beginning with 1890. It is stipulated that at least 2,000 copies of the proceedings of the annual convention shall be printed and distributed. Particular activity has been shown by the association in recent years. It has provided for the expenses of a dairy speaker at a dozen or more farmers' institutes annually, has issued good reports, and also distributed circulars of information as occasion required. Much of this evident enterprise is credited to the present secretary, S. C. Bassett, of Gibbon, who is cordially supported in his good work by the president, E. F. Howe, of Crete, and by a wide-awake board of directors.

The South Dakota Dairy Association was organized in 1892, and held its fifth annual convention at Huron in January, 1896. The president is A. H. Wheaton, of Brookings, and the secretary, W. F. T. Bushnell, of Aberdeen. No State aid is yet given to the association, but the last annual meeting was well reported through the enterprise of the Dakota Farmer, of Aberdeen.

The North Dakota State Dairymens Association held its second annual meeting in February, 1896, at Fargo. J. P. Power is president and E. E. Kaufman is secretary. The latter is dairy instructor at the State Agricultural College. Although in its infancy, this association has made a good start, and its proceedings have been published by the State department of agriculture and labor, whose head, A. H. Laughlin, is ex officio State dairy commissioner.

In all three States there have been farmers' institutes held for some years, and the dairy has been given fair consideration in the selection of topics for discussion. The State university and agricultural colleges encourage these meetings and furnish lecturers. They are also materially aided by the liberality of the railroads. The latter might well do more in this direction, as it is plainly in their own interest to foster any kind of educational meetings among the farmers. In Nebraska the institute work is well organized, although without State aid. In the Dakotas the work is not so systematically done and there is great room for improvement.

No dairy journal is published in any of these States, and none appear to be largely read among their farmers. The general agricultural papers give more or less attention to dairying, and a number of the county and local papers do likewise. There is opportunity for much usefulness through these channels, and it is suggested that the State dairy associations might accomplish great good by preparing weekly a column or so of well-selected dairy literature and distributing it to the local journals, which would, in nearly all cases, be glad to get this material and use it. The expense of such an undertaking would be moderate and would be fully justified by the missionary effect.

In the line of technical dairy instruction, the Dakotas are in advance of Nebraska. Lectures on dairying are given in connection with the agricultural course and the "short course" at the Nebraska State university at Lincoln, and these are accompanied by a few practical exercises. It is said to be the purpose of this institution to soon erect a dairy building and operate a small creamery. At the State college at Brookings, S. Dak., there is a neat little creamery in operation, and instruction, both theoretical and practical, is given in the making of butter and cheese. A cheese-curing room is a much-needed addition, and for this climate such a room should be built half under ground. The citizens and corporation of Fargo, N. Dak., contributed the funds necessary to build a commercial creamery in connection with the State agricultural college at that place. This is well managed and forms the basis for a yearly course of creamery instruction, and also a three months' course in the winter.

The conditions prevailing in all these States are such that much more good might be accomplished by perambulating dairy schools, operating a month in a place, after the plan successfully followed in

England, Ireland, and Belgium. The number of persons who might thus be instructed is very large as compared with the few who are able to attend the college courses, and the great need at present is to reach the isolated private dairymen or farm dairies and improve their methods. The creameries and factories can supply themselves with expert butter and cheese makers with comparative ease.

FARM DAIRYING AND CREAMERY PATRONS.

In Nebraska dairy farming has been well established in the eastern half of the State, and especially in the southeastern portion. It is also carried along the southern counties of the State almost as far as the eastern boundary of Colorado. An exceptional dairy district is found in some of the northwestern counties. There are comparatively few of the farmers as yet, however, who really make a specialty of this branch of agriculture. Most of them milk only 3 or 4 cows, or half a dozen at the most, and if they do not sell milk or cream their surplus butter generally goes to the local storekeepers in trade and finds its way largely to the "ladlers" or dealers in promiscuous butter. The latter report quite an improvement in the quality of farm dairy butter made in the State during the past ten years.

Sarpy County, on the eastern boundary of the State, is quite prominent in dairying. One-tenth of the farmers are dairymen, keeping an average of 12 cows. Nine-tenths of these animals are grades and nearly one-tenth are of full blood. The milking period is nine months. The pastures consist of blue grass, timothy, and the native grasses of the prairie. Winter care and feeding is good and constantly improving. From 3,500 to 5,000 pounds of milk per cow is expected in the season. The milk is set in stone jars, tin pans, and deep cans; a few hand separators are used. The farmers find markets for their butter in Omaha and vicinity and sell to private customers at 20 and 25 cents a pound; some contract at 20 cents for the year. In a few cases 25 and 30 cents have been regularly paid for a superior article. The proximity of Omaha is the chief incentive to the dairy development in this county.

In Platte County, in the central eastern section, about one-fourth of the farmers make a specialty of dairying, and their herds average 20 to 25 cows. The pasturing season is for four or five months, and the stable feeding embraces ground corn and oats, hay, corn stover, and millet. Milk is generally deep set, and some separators are used. Swiss cheese and soft forms of cheese are made to a considerable extent in this county.

A little farther west, in Boone and Greeley counties, dairying is still a side issue and mainly confined to the vicinity of creameries. Farms will average about 5 cows, and these are milked not more than eight months. The pasturing season lasts five or six months, the natural grasses of that region being excellent and the chief reliance. In winter, straw stacks and stalk fields replace the pastures, but some hay and grain are fed, and the building of several silos during 1895 indicates increased interest in dairying and a better appreciation of the efforts necessary to success. Most of the milk is produced between April and October, and there is little activity in winter. Jersey and Holstein blood is seen in the herds, but an annual milk production of 2,500 pounds is accepted as satisfactory. Deep setting of milk is practiced, and the butter produced sells at 7 to 15 cents per pound.

In the southern and southeastern part of the State, in the counties from Adams to Jefferson, only 5 per cent of the farmers are reported as engaged in dairying. These keep from 5 to 10 cows to a farm. Two acres are represented as carrying a cow, on natural pasture, but an estimate of 3 acres to a cow seems more general and reliable. The pasturing season runs through six months, if not uncommonly dry, and the cows are milked only seven or eight months. Winter care is poor, with little feeding except at stacks. Yet one farmer who has improved stock says he is able, by soiling, to make 1 acre support a cow, and he adds: "My experience in Nebraska is that if one keeps good cows and feeds them well they are as profitable as in any other State."

Personal observation appears to justify this last opinion, at least for the counties of Nebraska lying east of Adams. But it seems necessary to resort to soiling, more or less, for satisfactory results, and more use should be made of alfalfa, if it will grow as indicated by numerous trials. The dry seasons to which this region is more or less subjected kill off the tame pastures badly, and it is very unwise to break up the native prairie sod unless one is prepared to resort mainly to soiling as a substitute.

The conditions applying to Adams County, as above, and to Webster, immediately south of it, also apply to the double tier of counties extending westward from these along the southern border, at least halfway across the State.

Some exceptional conditions are reported from northwestern counties, especially Boone and Sheridan. This region was settled in 1885 and continuous wheat growing was practiced until stopped by droughts and low prices. Now about half the farmers keep cows, from 2 to 6 or 8, possibly averaging 6. A few herds are reported of 15 to 20 cows each. Most of the cows are grade Shorthorns, and they are milked eight or ten months, although they have fresh pasture only about five months. The feed consists of the native buffalo and other grasses, which cure upon the ground, so that a sort of unharvested hay is available in the fields or on the range during most of the winter. If covered with snow, hay, cornstalks, and perhaps a little grain are fed under sheds. Deep setting is the prevailing way for handling the milk, and 150 pounds of butter in a year is a usual product per cow. Some of this butter finds special markets at 15 to 25 cents per pound, but much the greater part of it is traded at stores and shipped to the ladlers.

Private dairymen all over the State are gradually improving in the care taken of their milk, and hence the quality of its product. The same is true of those who sell to the creameries. The use of deep-setting methods is becoming general, but there is room for much improvement in detail. For cooling milk, tanks have to be generally depended upon, into which water is lifted by wind or other power. In many cases the water enters the tank near the top, on one side, and the outlet or overflow is just opposite; this develops very little motion of the water in the tank. The inlet pipe should open at the bottom of the tank, to insure full benefit from the fresh, cool water. Where wind is depended upon to change the water and fails, the tanks are too often neglected. The handling and ripening of the cream does not seem to be as well understood as the cooling. As said before, there is evident need of missionary work with good dairy literature or an itinerant dairy school.

Cheese making on farms is practiced more or less, but it is difficult to obtain any reliable data on the subject. The secretary of the State association estimates that something over half a million pounds were made in 1895. This would indicate that about 150 farmers make cheese at home, from an average of 13 or 14 cows each. The most important need in this work is knowledge of the correct construction and management of a curing room.

In South Dakota the conditions are much the same as in Nebraska, and it is needless to give reports received from different counties, in detail. Dairying has been developed mainly in the eastern half of the State. There are a few experienced dairymen doing good work, but most of the milk is produced by farmers who keep a few cows apiece, simply as incident to their general business.

As an example of what it is possible to do in the way of farm cheese making in this State, the following is copied from a recently published letter from the owners of a dairy at Ordway:

> Our prairie hay is considered very nutritious and it is certain our stock does well on it. We raise considerable grain of one kind and another, but, except as that helps out our feeding, we find that stock raising and dairying pay better. During the year 1895 we made from 27 grade Holstein cows 15,250 pounds of cheese, or an average of 565 pounds per cow. This was cured in a temperature of 65° to 70° F., and sold to realize 9¼ cents net per pound. We raise all our good calves, feeding them after 1 month old on whey, to which is added wheat bran and middlings or bran and barley meal.

The following table of reports from creamery patrons in South Dakota was recently compiled and published by the Dakota Farmer:

Reports received from farmers in South Dakota.

Post-office.	Number of cows milked.	Number of months covered by report.	Total amount received for cream.	Average per cow per month.	Per cent of fat in test of milk, average.	Number of calves dropped during time of report.	Value of calves dropped during time of report.	Are reports encouraging?	Number of cows will milk next year.
Aberdeen[1]	7	12	$285.19	$3.40	3.7	6	$35.00	Yes...	10
Esmond[2]	24	5	200.00	2.00	4.4	....	....	Yes...	21
Huron[3]	12	7	325.75	3.87	....	12	50.00	Yes...	20
Huron	12	9	305.00	2.82	3.9	12	120.00	Yes...	21
Huron[4]	21	9	425.86	2.25	3.7	21	189.00	Yes...	21
Huron[5]	22	9	538.53	2.45	3.8	16	100.00	Yes...	30
Huron[6]	10	7	197.44	2.82	4	6	36.00	Yes...	20
Iroquois[7]	9	12	182.93	1.60	4.2	9	72.00	Yes...	12
Iroquois[8]	12	12	382.12	2.65	4.1	12	96.00	Yes...	18
Kidder[9]	12	9	324.00	3.00	4.3	12	120.00	Yes...	30
Lake Preston[10]	5	2	52.69	5.22	4.4	3	27.00	Yes...	15
Millbank[11]	10	12	....	3.50	4	10	40.00	Yes...	10
Waukonda	5	7	103.00	2.91	4	6	55.00	Yes...	6
Do	4	7	67.00	2.40	3.9	1	3.00	Yes...	6
Madison	6	8	180.54	3.76	....	....	....	....	....
Do	6	6	102.06	2.83	....	....	....	....	....
Do	8	12	298.93	3.11	....	....	....	....	....
Do	12	12	275.07	1.92	....	....	....	....	....
Do	13	12	423.65	2.72	....	....	....	....	....
Do	2	4	42.89	5.36	....	....	....	....	....
Do	7	12	167.21	2.00	....	....	....	....	....
Do	4	10	113.36	2.83	....	....	....	....	....
Do	4	12	155.20	3.21	....	....	....	....	....

REMARKS.

[1] I did not milk over six at any one time during the year.

[2] Cows are strippers; am expecting new milkers soon.

[3] I consider the creamery business the best of any occupation.

[4] Huron creamery now getting 49,000 pounds milk per week.

[5] Received and fed to hogs about $25 worth of skim milk.

[6] Think the farmers of Beadle County are on the way to prosperity.

[7] Cows had nothing but hay the whole year; will feed grain next.

[8] These were just ordinary cows and cost not more than $15 each.

[9] Dairy business paid me more cash than did 500 acres of wheat.

[10] Want 25 cows as soon as can get them; had none come in early.

[11] Our cows have averaged $40 per year, and that is good.

In North Dakota the same state of affairs has been observed and reported. The greatest dairy activity prevails in the counties of Cass, Grand Forks, Dickey, Ransom, and Sargent. The usual milking period is seven months, and of these four are passed on pasture. The bulk of milk is produced during May, June, and July, and the average yield for the year is 3,000 pounds per cow. Private dairies generally practice the deep setting of milk, in water, pumped into tanks. Butter is largely sold to customers in the neighborhood or within easy reach, in 5 and 10 pound jars, at 20 cents a pound in summer and 25 cents in winter. There is a considerable quantity, however, which goes to the storekeepers at less than 10 cents a pound and is shipped out of the State to be ladled.

The reason for so much of this butter going to this questionable object is its very poor quality and condition from the time it leaves the farms where made. It is not even good enough for the local demand, which still exceeds the supply in many sections of the State. Thus the farmers lose their home markets and get but half price for their product, because they will not learn to make better butter, take proper care of it, and make it in a rational way.

Active measures should be taken by the dairy associations in these three States to improve the quality of farm-made butter and stop the heavy loss resulting from the large contributions from these States to the supply of "ladled." The creameries are doing a good work in their way, but for years to come there will be farmers who can not well be creamery patrons, and these need all the help that can be given them. Attention may well be called to the work which several States, notably New York and Wisconsin, are doing to improve the grade of dairy products from the farms as well as from the factories. This same line of work is still better organized and conducted in Canada, with apparent and gratifying results.

LADLED BUTTER.

In all parts of the country where butter is made by small farmers at their homes, more or less of it is disposed of at the country and village stores. Of this, the condition of a considerable part is such that the merchants can not sell it to their retail customers. These numerous small lots of poor, damaged, and thoroughly bad butter have to be disposed of as grease or go to establishments which gather large quantities of the material and so manipulate and "renovate" it as to bring it into a merchantable form as a food product. In the butter market quotations these goods are called "ladles."

The newer dairying districts produce immense quantities of this class of butter, or that which, after treatment, comes to be thus known, and the largest establishments for handling this material are in the Northwest. One or two are located in Nebraska. There are none yet in the Dakotas, and the ladle butter from those States is at present sent to Minnesota and Iowa factories for renovation; some of it to Chicago.

It is impossible to determine with any accuracy the quantity of this low-grade dairy butter made in the three States under consideration which is contributed to the ladle-goods business. The rapid increase in the number of creameries tends to reduce this business, but farm dairies seem to be multiplying with equal rapidity, thus maintaining the supply. A careful canvass of the larger firms and their courteous replies to inquiries has enabled the following estimate to be made, and it is considered approximately correct:

Ladled butter produced in the year 1895 from the States named.

	Pounds.
Nebraska	7,400,000
South Dakota	1,300,000
North Dakota	500,000
Total	9,200,000

Not included in this estimate is the butter shipped from these States to ladle factories east of the Mississippi River and that which, originally shipped out of the States where made as private dairy butter of fair grade, finally finds its way to the ladlers.

This business is carried on as follows: The local storekeepers take butter in exchange for goods. The price allowed all producers at any one store is the same, quite regardless of the quality of the butter; it is necessary to treat all the farmers alike. As a rule, merchants sell what they can of the best received, without any profit or at an advance of 1 or 2 cents. The remainder, which in most cases constitutes much the greater part of the receipts, is dumped into receptacles of all kinds, and periodically sent off to the centers for ladling. Flour barrels, starch boxes, shoe boxes, and soap boxes have been indiscriminately utilized for this purpose. Much of this so-called butter is of such character that it makes little difference how it is neglected. The carelessness and indifference shown in some places is shocking. The receptacles are left open, no attention paid to the mixed contents, and they are not sent away until full, or until the mixture becomes so offensive that it must be got rid of. The one requirement of the package has been that it should not leak and waste too much, if the contents melted to oil in transit. Economical motives alone seem to have led to a reform in this regard. The ladlers now send out what are called butter stands to their regular sources of supply. These are large oak tubs or barrels, generally somewhat conical, with large bottoms to prevent overturning, tight covers, and strong handles. These are shipped to the factory when filled at the store. The contents of some of these tubs upon arriving at the ladling establishment is simply indescribable; the many small lots of butter—as the material was probably at one time entitled to this name—differ in color, salt, texture, age, and other respects, and sometimes the tubs contain articles quite foreign to the dairy, like bacon rind and mutton-chop bones. In cold weather it is possible to measurably separate and sort the different lots; in hot weather it is simply a mass of grease, not sufficiently melted to be homogeneous, but so far advanced as to make it impossible to vouch for all being originally butter fat.

The ladlers receive this material, grade it as best they can, and make their own returns to the shippers, as to both weight and quality. During the season of 1895, the average price paid by ladlers for shipments from these three States, was just about 10 cents per pound, the shippers paying freight to Omaha, or wherever the factory was located. Freight charges probably averaged half a cent a pound.

There are efforts in progress on the part of ladlers to improve the quality of their product by securing some degree of care in the collection and transportation of the country butter. Merchants are encouraged to hire collectors to get the butter from the farms, uncolored and unsalted. The following circular letter from one of the ladling concerns further explains this business:

> May 8, 1895.
>
> **Gentlemen:** We ask your attention to this circular regarding the handling of butter during the summer months. The low price of butter on the Eastern as well as the Western markets warns us to use every effort possible to turn out a better grade of butter than ever before, for this reason: The butter market has come to that point where the quality governs the price; much of the poor butter is caused by improper handling, and we offer a few simple yet valuable suggestions which we ask you to carefully consider.
>
> (1) When you receive butter from the farmers keep the good butter separate from the poor.
>
> (2) Keep your butter in a cool place, free from all odors of any kind.
>
> (3) Don't hold your butter longer than necessary to get a shipment, for every day you hold injures the quality of the butter and consequently reduces the price.
>
> If you send us good, fresh stock you are sure to get the highest price in return, and a trial shipment of butter will convince you that we mean business and will follow out the principles of this circular to a letter. We are in business to stay, and as our reputation is at stake we feel it is for our best interests to give our shippers, one and all, a square deal, top price, and prompt returns every time. At present, regardless of the low price of butter East and West, we quote you the following cash price f. o. b. your station: Good, fresh butter, per pound, 8 cents; poor butter, per pound, 6 cents.
>
> Our butter stands we furnish free, but parties shipping to other buyers our stands will be charged $1 for each stand.
>
> Thanking you for past favors, and hoping to receive a continuance of your patronage, we remain,
>
> Yours, truly, ——— ———.

The profit of the ladlers lies in intelligent grading and increase in weight by salting, washing, and reworking; also, more or less, in the success of the various processes used in eliminating rancidity, and restoring the semblance of grain and flavor to the mass. The article resulting is called butter and goes into the butter market, but it may well be doubted whether, as a food product, it is as good as average butterine. As a rule, "ladles" are quoted in the Chicago market at about two-thirds the price of creamery butter and about four-fifths the price of dairy butter of like grade, "extras," "firsts," or "seconds." What is known as "imitation creamery" is, as a rule, nothing but selections of the best of the ladled goods.

There is no intention of fully describing here the processes of ladling at the establishments built for that purpose. These processes differ a good deal and involve both mechanical and chemical treatment of the butter. The present purpose is to call attention to the large quantity of farm-made butter which goes through this mill and takes this low grade, which ought to yield the producers half as much again, and perhaps twice as much, and would do so if the right methods of manufacture were adopted. The extension of the creamery system is probably the surest and the quickest way of correcting the evil. But much farm-to-farm teaching of the elementary principles of caring for milk and of making and marketing butter is needed.

CREAMERIES.

With a view to making a report upon the creameries of Nebraska, South Dakota, and North Dakota, and upon their work, without spending too much time in personal inspection, blank forms were prepared and distributed in the hope of thus securing the main facts, which might then be summarized. The most accurate lists obtainable of these establishments in the States named were used, but the result, as given in the following table, shows the difficulties attending such an effort and the uncertain value of the information thus obtained.

Number of blanks sent and replies received from creameries and cheese factories.

State.	Blanks sent.	Returned undelivered.	Supposed to be delivered.	Replies received.	Per cent of replies.	Remarks.
Nebraska	145	24	121	29	23	Two cheese factories.[1]
South Dakota	108	17	91	27	30	Two cheese factories.[1]
North Dakota	28	0	28	9	32	One cheese factory.[1]
Total	281	41	240	65	27	

[1] Included because so few.

Replies having been received from only one-fourth of the factories believed to be in operation at the time, it is manifestly useless to tabulate the returns for use in a statistical way. But assuming that the reports received were from representative establishments, they form, in connection with notes taken at the creameries which it was possible to visit, a reasonably satisfactory basis for sundry remarks and suggestions.

Nebraska has suffered from three successive seasons of extreme drought. Yet in comparing results with other States, her creameries appear to be able to do about as well, in rates of payment to patrons, as the northwestern dairying regions in general. And this, too, notwithstanding the frequent necessity for long hauls to the creameries, and consequent increase in the cost of manufacture. The farmers in this State who have been turning their attention to dairying, as creamery patrons, have done better in fact than they appear willing to acknowledge in conversation. Claiming that they had no time to milk cows, that they had unreliable pastures, and that they ought to let cows alone and cultivate their farms—it was easily proved, and often finally admitted, that the cows paid better than the crops, and during these trying years they would have starved, had it not been for the sales of milk, cream, and eggs.

It is evident here, as in most parts of the West, that the farmers spread their labor over too many acres of land. Better attention to smaller areas under cultivation and the provision of fodder crops to help out dry pastures would rapidly improve the condition of most of those visited.

The creamery buildings in the State are of varied quality and capacity—good, bad, and indifferent. The gathered-cream plan was unfortunately adopted very largely at first, and when the introduction of the separator caused a very general change of system, mistaken economy led to inadequate changes in the buildings, so that many creameries are now operated in quarters which are cramped, inconvenient, and hard to keep clean. Nevertheless, the average condition of Nebraska creameries as to buildings and equipment compares favorably with that in other States.

The West Point Creamery was the pioneer in this business in Nebraska, and probably the first to operate west of the Mississippi. It was established as early as 1878, before there was a creamery in the New England States. New York men were largely interested in the enterprise at its start, and as milch cows were then scarce in Cuming County, the company took up 800 acres of land and procured a stock of over 300 cows, so as to produce most of the milk needed. Guernsey and Jersey bulls, as well as some cows, were brought from the East, and the company graded up its herd. Holdings were increased, lands leased, and at one time the company owned 1,700 head of high grade dairy cattle. Feeding these cattle involved farming operations on a large scale, and as butter was the main article for sale, a large business was done in raising hogs on the skim milk. The silo system was adopted, and the farm has storage capacity for 800 tons of silage and 500 tons of sugar-beet pulp. As fast as offered this creamery took the product of neighboring farms on the cream-gathering plan and early adopted the advanced method of paying on the basis of tests by the oil-test churn. In 1891 the company was reorganized and has since done less in farming and live stock, but the creamery business has been extended, and besides butter, large sales of milk and cream are made in Omaha. The company has a large depot there and regards that city as the center of the market side of its operations. Enough cream is still bought in West Point and vicinity to make about 1,500 pounds of butter a day in the height of the season. The milk from 275 cows, on the home farm, mainly goes to the city market. One hundred heifers of high-grade Jersey and Guernsey blood are being reared to maintain and increase the herd. The entire establishment is under most capable and systematic management. A complete record is kept of the performance of every cow, and all the operations in the creamery are also the subject of current record. Yet it seems odd to find in such a large establishment that no separator is used, cream being raised by the old gravity method, with shotgun cans in cold pools, and fat tests of the skim milk and buttermilk are still unknown.

The daily milking of 200 to 300 cows is a serious business anywhere, and the labor question involved is often a difficult problem to manage. The West Point Creamery has adopted and successfully conducts a somewhat unusual system. From families of foreign extraction in the neighborhood, 20 women are hired for an hour and a half at morning and the same time at evening, daily; these do the milking and do it exceptionally well and economically. They are paid 30 cents a day, and each one milks 14 cows in the allotted time; some of these women draw 300 pounds of milk in 90 minutes or less.

The Nebraska Creamery Association is located in Fremont, right in the city, and it operates there the largest plant of its kind in the State. This was established in 1881, being organized as a stock company, and it is still conducted as such. It has always been run on the cream-gathering plan, modified by the circumstances of location and the extent of the business. Cream alone is brought to the central factory. The supply is drawn from parts of 8 different counties, and comes by wagon over 20 routes, and also by rail from several separating stations maintained by the company at suitable points. All the gathered cream is sampled and subjected to the old style churn test, and upon these test results the payments to patrons are made. At the stations the milk is sampled and tested for fat by the Babcock method. At times in the past it was found that the cost of gathering cream by wagons was much too great, reaching 7 cents to the pound of butter, in some instances. Hence the plan has been adopted of paying cream gatherers according to quantity of butter made from the cream they deliver; 3 cents per pound of butter is paid in winter and 2½ cents in summer. Various checks are used upon the gatherers to insure freshness and quality in the cream they bring. The factory managers greatly prefer cream from their own separating stations because in so much better condition, resulting in a higher grade of butter. The railroad freight on the cream from stations within 30 miles is 15 to 20 cents per can of 10 gallons, can returned free. With the exception of small local sales, this large establishment makes all the cream it receives into butter, and generally sells the entire product to dealers who receive the same at the railroad platform adjacent to factory. Buttermilk is sold to patrons at 25 cents a barrel, and to outsiders, who buy it quite largely at the factory, at the same price for a 10-gallon can. The largest business was done by this creamery in the year 1887, when as much as 2½ tons of butter were made per day. Various causes have since decreased the product, which has been from 1,000 to 1,500 pounds daily during the past year. Patrons at the separating stations have lately been paid an average of 12 cents per pound of butter fat in the milk delivered by them; and those upon the gathering routes have been paid 10 and 11 cents per pound of butter oil, determined by the oil-test churn.

It is worthy of note that several attempts by farmers in the vicinity of Fremont to conduct cooperative creameries have failed. These have been small concerns and without experienced business management. The rivalry of the big factory, and the economy possible because of the extent of its operations, appear to have been too much for successful opposition. Yet this creamery has never paid large dividends to its stockholders, and at times it has run at a loss. The capital stock was originally $50,000, but it has been reduced one-half.

Among the creameries of Nebraska, a group known as the South Platte creameries is worthy of special note. These are located in the four adjoining counties of Butler, Polk, York, and Hamilton, the central factory and office being at Aurora, in the last county named.

The Waterloo Creamery Association is another large concern, owning 1,500 acres of land and keeping 400 cows in Douglas County. It is mainly engaged in the milk supply of Omaha, having its office and principal depot in that city.

In South Dakota, the creamery business may be fairly said to have been "booming" during the years 1895 and 1896. Fully 100 new creameries commenced business in the spring of 1896. Nearly all of these are separator factories, no other system being heard of now. A good many of these are cooperative creameries, and such have naturally made the best payments to patrons. The highest average payment for milk reported the past season was 73 cents per hundred pounds, by a cooperative concern, and from this the rates ranged down to 49 cents for a proprietary factory. The average for the State must have been about 62 cents per hundredweight of milk. This shows an excellent average quality of milk.

It is interesting to note that the greatest successes in these new creamery ventures have been in neighborhoods where crop failures have seemed disastrous. This is partly explained by the remark of one patron: "Yes, I like the creamery first rate. Last year I kept only 3 cows and this year have 24. I *had* to do *something*, and the cows were the only things that paid. But I had to be starved into feeding them and milking them."

A good many of the creameries a year or two old, some even less, have had to be enlarged and their general condition seems to be healthy. Some failures there must be, and a few cases are noted where crop failures were so complete as to force patrons to sell their cows.

North Dakota reports are few and unreliable. In this State a good ice supply can be relied upon and the cream-gathering system is therefore in more favor. The average quality of milk seems to be even better than in South Dakota, but the payments to patrons for milk and cream are at lower rates. All the natural conditions favor the rapid and successful extension of dairying under the creamery system in the southeastern portion of this State.

Nearly all the creameries in these three States are built of wood, with iron smokestacks, and, according to the best information obtainable, not one-third of them are insured. The most common causes for criticism are faulty management of the waste products, buttermilk and skim milk, and insufficient provision for drainage, which will surely result in serious trouble after a time. The general interior care is of about average grade, but in a good many places there is need of constant repetition and enforcement of the fundamental creamery rules for order and cleanliness.

CHEESE FACTORIES.

Cheese making on the factory plan has not become established to any extent in the three States under consideration. North Dakota seems to have done more than the others in proportion to age and population, although the aggregate product of Nebraska is larger. It is claimed that during last year about 1,000,000 pounds of cheese were made in factories in the latter State and about half as much on farms. In North Dakota the estimate for the same year is 400,000 pounds for factory cheese; this is probably in excess of the fact. In Nebraska reports show about 9½ pounds of cheese produced from 100 pounds of milk, and North Dakota reports show something over 10 pounds. In the former State one factory paid an average of 63 cents per hundredweight for milk; this was doing well. The factories in these States seem to run very short seasons, and their greatest difficulty is in curing. Good curing rooms are rare. In Nebraska, and perhaps in South Dakota, it will probably be found necessary to put the curing room partly under ground to secure even temperature, but it must be kept dry and well ventilated. Expensive buildings are needless. In some parts of the West there are cheese-curing rooms dug 4 or 5 feet into the ground, carefully drained, and the earth walls simply lined with matched boards; there is a building above to partly shade the place. Such rooms, properly managed, are found to answer their purpose well.

The progress made already shows that opportunities and conditions are good for successful cheese factories in Nebraska and the Dakotas, and their number can be largely increased to advantage if a home trade can be worked up for their products. This should not be difficult.

EXTENT AND VALUE OF DAIRY INTERESTS.

From all obtainable data, an estimate has been made of the principal items connected with the dairy industry in these States. The figures given in the following table can not be verified, but there are good reasons for considering them approximately correct:

Extent and value of dairy interests in Nebraska, South Dakota, and North Dakota.

State.	Milch cows owned.	Value of cows (estimated).	Milk produced—yearly quantity and value.				Creameries.	Cheese factories.
			Average yield per cow.	Total milk produced annually.	Value of milk per cwt.	Total value of milk produced annually.		
	Number.	*Dollars.*	*Lbs.*	*Cwt.*	*Cents.*	*Dollars.*	*No.*	*No.*
Nebraska	563, 313	13, 000. 000	2, 430	13, 688, 500	53	7, 254, 905	119	2
South Dakota	278, 928	6, 400, 000	2, 500	6, 973, 000	61	4, 258, 530	89	2
North Dakota	146, 328	3, 250, 000	2, 300	3, 365, 000	55	1, 850, 750	27	6

The most probable cause of error in this table is the low annual milk yield assigned to the cows in these States, but the rates given are sustained by reports of actual facts, which appear to be reliable. The figures exhibit the average milch cow of this region to be an animal of very doubtful profit, for in South Dakota, which makes the best showing, the gross income per cow, in milk, would be but $15 a year.

GENERAL REMARKS.

An evil which exists in these States, and appears to be increasing, is the system of short-term tenantry on farms. The extension of dairying and progressive farming in any form is likely to be very slow while this system prevails. It is usual to find in almost every town and village in these States capitalists (or their agents) who own several farms and who rent them on shares. This would not be very objectionable if the farms were leased for terms of ten years or more. But the one-year term is very common, if not the rule, and this is detrimental alike to the interests of owner and tenant. It is incompatible with good farming, and sure to result in deterioration of the farms. Bankers, agents, and all concerned should encourage the division of lands into small farms and their settlement by owners, or leasing on long terms, if at all.

Bankers, merchants, and professional men do not seem to sufficiently realize how closely their interests are allied with the condition of farming in their region. They should encourage enterprise in farming in every possible way; aid and patronize educational organizations, institutions, and meetings—like farmers' institutes, conventions, and dairy schools—and generally assist in the application of intelligence and enterprise to the farm and dairy interests of their States.

○

BULLETIN NO. 17. (Dairy No. 8.)

U. S. DEPARTMENT OF AGRICULTURE.

BUREAU OF ANIMAL INDUSTRY.

DAIRY SCHOOLS.

BY

R. A. PEARSON, B. S.,
Assistant Chief of Dairy Division.

Under the direction of

Dr. D. E. SALMON,
Chief of the Bureau of Animal Industry.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1896.

LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ANIMAL INDUSTRY,
Washington, D. C., November 13, 1896.

SIR: I have the honor to transmit herewith the manuscript of an article on "Dairy Schools," prepared under the supervision of Henry E. Alvord, Chief of Dairy Division of this Bureau, and to recommend its early publication as a bulletin of this office. Dairy schools have been established in this country only a few years, but the good results of their work are already apparent. Many dairymen do not know of these schools or have only a vague idea of them, and it is the purpose of this bulletin to spread information on these points and to show some of the advantages of special training in dairy lines. An appendix to the bulletin contains statements of the facilities for instruction in dairying in the States and Territories.

Respectfully,
D. E. SALMON,
Chief of the Bureau of Animal Industry.

Hon. J. STERLING MORTON,
Secretary of Agriculture.

CONTENTS.

Page.
Dairy instruction 7
Purpose of dairy schools 8
Method of conducting dairy schools 9
  Requirements for admission 13
  Certificates and prizes 13
  Cost of dairy course 15
Equipment 16
Advantages of a dairy course 18
Advantages of dairy schools to the public 21
Appendix 23

ILLUSTRATIONS.

PLATES.

Page.
PL. I.—Fig. 1. Dairy hall, New York 16
Fig. 2. Dairy hall, Wisconsin 16
II.—Fig. 1. Churning room, dairy short course, Wisconsin 16
Fig. 2. Operating separators, creamery course, Wisconsin 16
III.—Fig. 1. Pasteurizing milk, Illinois 16
Fig. 2. Cheese room, Minnesota 16
IV.—Fig. 1. Milk laboratory, Minnesota 16
Fig. 2. Live stock lecture room, Minnesota 16

FIGURES.

FIG. 1. Receiving and sampling milk, College creamery, Iowa 16
FIG. 2. College creamery at Fargo, N. Dak 18

DAIRY SCHOOLS.

DAIRY INSTRUCTION.

The fact that a young man has attended a dairy school and has successfully completed the course there offered, commends him to anyone looking for a person to fill a responsible position in a creamery or cheese factory or to take charge of a farm dairy. Scientific education in agricultural lines is no longer looked upon as impracticable and useless, and the one possessing it is not now necessarily considered a theorist; on the contrary, education is regarded with more and more favor, it is recognized that practice and science are closely connected, and yield the best results when they are made to depend upon each other; rules of thumb can not compete with applied science. So far as special training is concerned, dairying is not different from other lines of industry, and in these times of rapid scientific and technical advancement and severe competition in all trades and professions, it is found that the butter and cheese maker and the dairyman are as much in need of the best and latest information relating to their work as the horticulturist or mechanic or tradesman is in need of the latest knowledge in his line.

Modern advances in dairy knowledge have been rapid; the scientist and inventor have caused the apparatus and routine in use a quarter of a century ago to be almost entirely discarded and replaced by more profitable machinery and more accurate methods. Although inventions of improved dairy machinery and scientific investigations in the field of dairying are comparatively recent, important discoveries and corresponding changes in methods of work have already been made. It is probable that these improvements have not much more than begun, and the results that have been obtained and will be obtained are certain to have a marked effect on the production and care of all dairy products. It is well known that the methods of butter making practiced twenty years ago can no longer be followed with profit; with modern aids more butter can be made from a given amount of milk of a given quality than it was then possible to produce.

Another feature of dairying which has undergone great change in late years is the market value of dairy products. The prices of milk, butter, and cheese have recently been so low and the cost of production has so nearly equaled the market values of the products most economically produced, that it has become absolutely necessary to turn everything in dairy operations to the greatest possible gain if one would succeed in profitably producing milk, butter, or cheese. Skill and keen judgment are constantly required by the successful dairyman; no simply imitative methods can be depended upon if the best results are expected.

The changing conditions of the dairy industry, viz, its rapid advances in means and methods of manufacture, larger production of goods not always the best, and severe competition, have seemed to make it necessary to provide some places for giving instruction in the most advanced dairy methods. Dairy schools have been established to meet this pressing need, and their establishment marks an important era in the history of agricultural education. Soon after the organization of agricultural colleges it was learned that they could not reach, through the long courses, the great majority of dairymen and butter and cheese makers who needed practical and theoretical instruction. Shorter courses were offered, with varying success, and it was finally decided to give instruction in dairying alone for a few weeks each winter. This departure has proved to be a boon to dairying. Dairy schools are now found in every State where dairying is a prominent industry, and other States are ready to give similar opportunities for dairy instruction as soon as it is needed. These schools are usually connected with State agricultural colleges which furnish instructors and equipment. In a few States splendid buildings have been erected for the single purpose of dairy teaching. In other States creameries or cheese factories or buildings containing both have been erected for the practical operations, and class-room work is conducted in the college buildings. Schools with the largest equipment are naturally located in the chief dairy States.

PURPOSE OF DAIRY SCHOOLS.

It is the purpose of dairy schools to teach young men or women, in a short time, as much as possible of the theory of the different lines of work connected with dairying; and these theories are illustrated, so far as practicable, in actual practice at the churn, cheese vat, or other apparatus. They aim to so equip one who has had some practical work that he will be able to take full charge of a plant and make the best possible product. And they attempt to teach one who has had little or no practical training the things that it took his father many years to learn. They aim to improve the quality of our dairy products and to reduce the cost of their production by teaching new and advanced principles, together with methods which have been proven to yield the best results. There is no reason why as good butter or cheese can not be produced in this country as is made in any part of the world, yet it is a painful fact that, while many of our manufactured products excel all of their kind made in other lands, our dairy products can not compete in foreign markets with the butter and cheese of several countries. Our successful competitors depend on their herds for their daily bread. They realize that it is to their interest to thoroughly understand every step in their work and have carefully organized systems of dairy instruction which have been conducted for years.

It is not the purpose of short dairy courses to displace longer courses in agriculture. Each has its own place in the field of agricultural instruction, and dairy schools occupy a place that had been practically vacant. The long course of agriculture which requires four years for completion is thorough and comprehensive, and if one desiring dairy training can take that it is undoubtedly the best thing to do. Four years is none too much time to devote to the study of dairying and closely allied subjects. If it is possible to spend only two years and few outside subjects are taken, a good training can be obtained in that time. By taking these longer courses one can obtain all the instruction given in the short course and a great deal more; in fact, he has an opportunity to learn much that is now known of dairying and at the same time gain a fair knowledge of agriculture, chemistry, bacteriology, and other subjects allied to dairying and of general importance and interest. But the full course in agriculture or a special course of one or two years requires time and money for preparation and completion, and it is, therefore, beyond the means of many to take either of them.

There is a large class of ambitious young men and women who can not afford a long course at college, and of others who are not interested in anything but dairying, strictly. With many the time is limited and they prefer to become as proficient as possible in one line, rather than attempt to get a few ideas in several different lines. It is for such as these, chiefly, that short dairy courses have been arranged, and it is endeavored to place them within the reach of all, as one of the first necessary steps toward the improvement of our dairy products is education of the *many* makers of butter and cheese. Each one must be properly trained, and schools adapted to but a few could not accomplish that end.

The dairy schools receive without special preparation any who are actually engaged in making butter or cheese, or who intend to make that their business. The work is so arranged that an intelligent person can get great help by devoting all his time for a few weeks to the study of dairy methods under the guidance of competent instructors. It must not be thought that all the complexities of dairying can be learned in a few weeks or months, but in this short period many useful ideas, advanced principles and methods can be obtained.

METHOD OF CONDUCTING DAIRY SCHOOLS.

As the most active season of dairying is in the spring, summer, and fall months, the period of work of the dairy schools has been placed in the winter, thus enabling many who are in charge of factories to finish the season's work, take the course, and open the factory the following spring, while others whose factories run the whole year can be relieved of the work for a few weeks in winter more easily than any other time. The schools being established for those who can attend but a short period, the work is so planned that on each week day the student's time is fully occupied. Care is taken to have the scientific and practical instruction so closely related that one will help the other in the daily work. The student is not only told in lectures how to make good butter and cheese, but he is shown the complete process and performs the work himself until familiar with it. After he learns the principles of making a first-class product he is shown how to judge or score it, a blank like the following being used:

Blank used for judging butter at the Wisconsin Dairy School.

Report by .... Date, ..., 189 .

No. of sample..........................							
Scale of points.							
Flavor..........................	40						
Grain..........................	30						
Color..........................	15						
Salt..........................	10						
Package..........................	5						
Total..........................	100						

This is an important exercise and a great help in detecting just where an error was made in the process of manufacture. It is also an aid to understand the expert criticisms of the product after it has reached market.

The subjects in which instruction is given depend largely on the condition of dairying in the State where a school is located. General lectures on dairying are given at all schools, and instruction in the use of the Babcock and lactometer tests and in butter making is always given. Cheese making is an important industry in only a few States, and the fullest instruction in that branch may be expected in those States where the most cheese is made. The pasteurization and sterilization of milk with different kinds of machines, and the preparation of milk for the retail city market, are taught in some States. A few schools have most excellent facilities for advanced work and original investigation in dairy lines, and students who are proficient in the elementary work are encouraged to take up something more advanced. The science of dairying offers a promising field for investigation and good reward for successful work. Many short-course students have become so interested in this that they have been led to take a full four years' course in agriculture after completing the short course, and have become leading authorities on agricultural matters in their communities. Sufficient practical engineering is given in some schools to enable one to do his own steam fitting, plumbing, belting, and simple repairing. Some bacteriology is taught and an effort made to impress the fact that bacteria are the chief cause of good or harm in the dairy. Under the head of chemistry, is taught the composition of milk and its products and the relations of their several parts. In a few cases students have opportunity to perform some simple operations in milk analysis, thus making a better impression on their minds than can be done by lectures alone.

The class usually assembles at 8 o'clock in the morning to take one or more lectures, which are intended to cover much more ground than the practical work. Some of the subjects discussed and which were not mentioned above are breeds, breeding, feeding and animal nutrition, selecting and judging cattle, manures, farm buildings, market quotations and requirements, veterinary science, law, and creamery bookkeeping.

Special attention is given to the lectures directly bearing on the daily practical work. The importance of having the best milk is clearly shown. All the details of handling milk both before and after delivery to the factory are explained. These include milking, straining, aerating, cooling, care previous to delivery, and hauling to factory; also the receipt of milk at the factory, the examining, weighing, sampling, and conducting to milk vat. The lectures on testing milk briefly describe the simplest tests which have been used and fully explain the method devised by Dr. Babcock. The payment for milk according to its fat content is explained and illustrated. In the lectures on butter making, every step of the work from taking the milk from the vat to shipping butter to the market is fully described. The lectures on cheese making cover that subject from the receipt of the milk to the shipment of cheese. Instruction is usually given in cheddar-cheese making only, but in some schools the manufacture of several kinds of cheese is described. The advantages, disadvantages, and best methods of pasteurization and sterilization are explained in some courses of lectures. The proper method of constructing dairy buildings is discussed, special importance being given to the sanitary side, the disposal of skim milk and waste products, laying of drains, etc.

The part of the instruction upon which most dependence is placed is the practical work. It is by means of this that new ideas are most effectually fixed in the minds of students. This should never be considered as manual labor, as it is not that in any sense. When the class-room work is completed different sections of the class are assigned to various duties in connection with practical dairy work, such as receiving milk, tending to separators, churning, cheese making, and pasteurizing and testing milk, and the assignments of the different sections are changed regularly, so that each student has an opportunity to gain experience in each branch of the work. In some schools the class is divided into three sections, each section working in the butter room, cheese room, and laboratory by turns. These sections are again divided into smaller sections and assigned by the instructor to perform different duties; for example, of those assigned to the butter room some take charge of the separators, others attend to the churning, while others print and pack butter. All the work is executed under the immediate supervision of a competent instructor and careful attention to details is required. When a student is assigned to any duty a report blank is given him similar to those here shown. It provides for reporting each step in the work, and thus teaches accuracy and observation.

Blank used for milk-testing report at the New York Dairy School.

Report by .... Date, ..., 189 .

No. of sample.	No. of bottle.	Lactometer reading.	Temperature.	Specific gravity at 60° F.	Per cent of fat.	Solids-not-fat.	Adulteration, kind and amount.

Blank used for separator report at the Iowa Dairy School.

Date, ... By ....

Temperature of milk when received........ ......
Temperature separated ....
Which separator used ....
Started separator at ....
Reached full speed at..................... ......
Fat in skim milk 5 minutes after starting .. ..
Fat in skim milk 30 minutes after starting.. ......
Fat in skim milk 1 hour after starting...... ......
Solids-not-fat in skim milk 1 hour after starting.................. ......
Fat in cream 1 hour after starting ....

Speed of separator 5 minutes after starting ....
Speed of separator 30 minutes after starting ....
Speed of separator 1 hour after starting... ......
Pounds of milk run through per hour...... ......
Temperature of skim milk.................. ......
Temperature of cream ....
Temperature of cream in vat............... ......
Temperature of water surrounding vat ....

Remarks:

Blank used for cheese-making report at the New York Dairy School.

Report by .... Date, ..., 189 .

Vat used ....
Condition of milk..........................
Weight of milk.............................
Rennet test for ripeness...................
Temperature set ....
Amount of rennet used......................
Rate of rennet per 1,000 pounds milk.......
Hot iron test when dipped..................
Hot iron test when ground..................
Weight of salt used........................
Rate of sale per 1,000 pounds milk.........
Per cent of fat in milk....................
Per cent of fat in whey....................
Weight of fat lost.........................
Kind of cheese.............................
Number made ....
Weight of green cheese.....................
Weight of milk for 1 pound green cheese....
Serial number..............................
Time set...................................

Time of first curdling.....................
Minutes taken..............................
Time cut ....
Minutes taken..............................
Time steam turned on.......................
Minutes taken ....
Time steam turned off......................
Minutes taken in raising to........degrees.......
Time dipped ....
Minutes taken..............................
Time ground ....
Minutes taken..............................
Time salted ....
Minutes taken..............................
Time put to press..........................
Whole time for setting ....
Time dressed...............................
Time taken from press......................
Length of time in press....................

Remarks:

Farm dairying, or the making of dairy products on a small scale, is usually taught in the short course of agriculture with other subjects, such as horticulture, general agriculture, and entomology. In most of the States where the factory industry is not extensive and the classes in dairying are not too large, the farm dairy instruction is given in connection with the creamery and cheese factory work. In this course it is endeavored to show how to make good butter in small amounts and with ordinary utensils, such as are found on the average dairy farm, as well as with the most approved aids. Lectures are usually given on breeding, feeding, and judging dairy cattle, management of the dairy, diseases of the dairy cow, the composition of milk, and the manufacture of dairy products. Practical work is included in separating cream by gravity and by hand separators, and making butter in small amounts and preparing it for the market. These courses have enabled many farmers to so improve their butter as to increase its price 2 or 3 cents a pound.

REQUIREMENTS FOR ADMISSION.

The entrance requirements to dairy schools are such as to debar no worthy person who really desires to attend. Any person of good character who wishes to study dairying and is capable of understanding the lectures and doing the practical work will be admitted to almost any school. In some cases there are age requirements, and in a few instances examinations are given or statements must be presented showing that the applicant has had a certain amount of experience in a cheese factory or creamery. These easy entrance requirements, however, should not encourage anyone who is not fitted for the work to attempt to take it. An applicant should be at least 16 years old, and it is well to have some knowledge of farm and dairy methods, although some of the best results have been shown by ambitious young men from the city who knew nothing of cattle or milk before taking the course. One should be possessed of a common school education, be able to read and write, and understand fractions, percentage, and decimals. Without such knowledge it is possible to make good butter or good cheese, but not possible to take charge of testing milk or apportioning dividends. Each student entering a dairy short course should have a strong desire to become expert in some part of the work, and this fact should be kept in mind throughout the course.

Women are usually admitted to the schools on the same conditions as men. They have always been interested in the farm dairy, and are now successfully taking charge of large dairy plants. It would seem a great mistake to exclude anyone engaged in dairying from attending a dairy school, which should be ready to aid as many as possible.

CERTIFICATES AND PRIZES.

Certificates are awarded by some schools to students successfully completing the course. These do not necessarily recommend the holder to fill any position in a creamery or cheese factory, but usually simply state that he has creditably finished the prescribed work. Such a one is here shown:

Certificate awarded by the New Hampshire Dairy School.

This certifies that ——— ——— has been a regularly enrolled member of the dairy school of this college during the session of 189—, has attended the lecture courses, has done the prescribed work with the separators and churns and in milk testing, and has been found proficient by his instructors in the exercises required.

Given at ———, ———, this ——— day of———, 189—.

——— ———,
Professor of Agriculture.
——— ———,
Creamery Instructor.

[SEAL.] Countersigned:

——— ———,
President of the College.

A student may finish the work of the dairy school and be able to make the best butter or cheese under similar conditions as were there afforded him, but he can not always do as well under the adverse circumstances sometimes met by practical butter and cheese makers. To successfully cope with all conditions long experience is required. Sometimes the certificate is not given until the student has had one or two seasons of practical work, concerning which a blank statement similar to the following is filled out and sent in monthly:

Blank used for report in creamery work by the Wisconsin Dairy School.

Report by ——— ——— for the month of ———, 189—.

Name of creamery in which you work..
Location of creamery: P. O..............., County..........., State................
Nearest railway station..
What position do you hold, first man or helper?..................................
Is creamery cooperative or private?........ Number of patrons..................
Number of cows........ Pounds of milk received daily..........................
Distance to next creamery or cheese factory....................................
Distance from creamery to farthest patron......................................
Are dividends made according to the per cent of fat in the milk?..................
Do you use composite test?........ How often is each patron's milk tested?.......
What is the highest per cent of fat found in any patron's milk during this month?..
What is the lowest per cent of fat found in any patron's milk during this month?...
Average fat in mixed milk from all patrons......................................
What separator is used?........ About what proportion of cream is taken?.......
At what temperature is milk separated?..
How much milk is separated per hour?...
What per cent of fat is left in skim milk?......................................
Have you been troubled by separator churning the cream?........................
How is cream ripened?........ How long is cream held before churning?..........
At what temperature is cream kept?...
At what temperature is it churned?...
How long on the average is cream churned?......................................
Is butter worked once or twice?........ How much salt is used?..................
What kind of salt do you use?........ Are you bothered with mottled butter?....

How much fat is left in buttermilk?..

What per cent lactic acid is in cream when churned (Mann's acid test, or Farrington's tablet)?..

How much butter, packed ready for market, is made from one pound of fat, as shown by test?..

How much butter has been sold during the month?..

State highest, lowest, and average prices obtained..

How much is charged per pound for making?..

Do patrons take back skim milk?..

How is skim milk divided among patrons?..

Remarks:

In addition to this he is visited at his factory by his former dairy instructors, whose reports must show that the factory is well conducted. A certificate based on these conditions is a valuable thing, and of course a great aid in securing a position.

The practice of giving prizes to the best students has been adopted in some schools. The award of these prizes is based entirely on the work done at the school. They furnish an incentive to put forth one's best efforts and they make the school work more interesting by causing friendly competition. It has been the custom in some schools of England to give the best students an extended and advanced course without cost.

COST OF DAIRY COURSE.

In a few cases tuition is required of all students admitted to the dairy course, but this is never a large amount, rarely exceeding $15. A deposit of from $2 to $5 is usually made to cover any loss by breakage, and the amount of this remaining unused is returned to the student at the end of the term. Each member of the course is given a full set of glassware for testing milk, and if he meets with no accident and returns a complete set he receives back the entire amount of his deposit. If a few pieces are broken, enough is deducted from the deposit to replace them and the remainder is returned. Board and room can be found at prices varying from $2.50 to $5 per week and laundry work costs about 50 cents more each week. Most schools require students to wear white suits when at work in the dairy building. Those made of white duck, similar to the ones worn by painters, are very satisfactory and can usually be obtained for $1 a suit. Each student should have at least two suits. The incidental expenses depend largely on the individual; they can be kept quite low if necessary.

It is thus seen that the total cost of attending a dairy school is very reasonable—exclusive of the railroad fare in going and returning—it may even be as low as $25. With few exceptions $50 will cover the entire outlay. Some energetic young men have been able to make a large part of their expenses while attending such a school by working in the barns and on the farms connected with the college, but it is not safe to depend on this unless assured beforehand that work can be obtained, as there are seldom as many positions as persons seeking them.

In the brief statements of the schools, in the appendix, the estimated amount of the required expense in each case is given. Laundry and incidentals are not included. Each student should have a few blank books for taking notes in the lectures and laboratories. The price of board and room varies with the location and the accommodations offered; the lowest price is usually stated.

EQUIPMENT.

A few schools are equipped with buildings which have been erected at the expense of the States for the purpose of dairy instruction only. These buildings are as complete and perfect in construction and as fine in appearance as other college buildings and lack nothing in arrangement or equipment which would aid in the purpose for which they are intended (Pl. I). They contain both lecture rooms and work rooms, also laboratories, reading rooms, libraries, bath rooms, and dressing rooms. Each building is so arranged that all the work connected with butter making is done in a part by itself, and practical cheese making is carried on in another part. The work rooms are arranged as nearly as possible like a modern creamery or cheese factory. The receiving room (fig. 1) contains a receiving can, scales, various arrangements for taking samples of milk, and milk vats or conductors leading to vats in

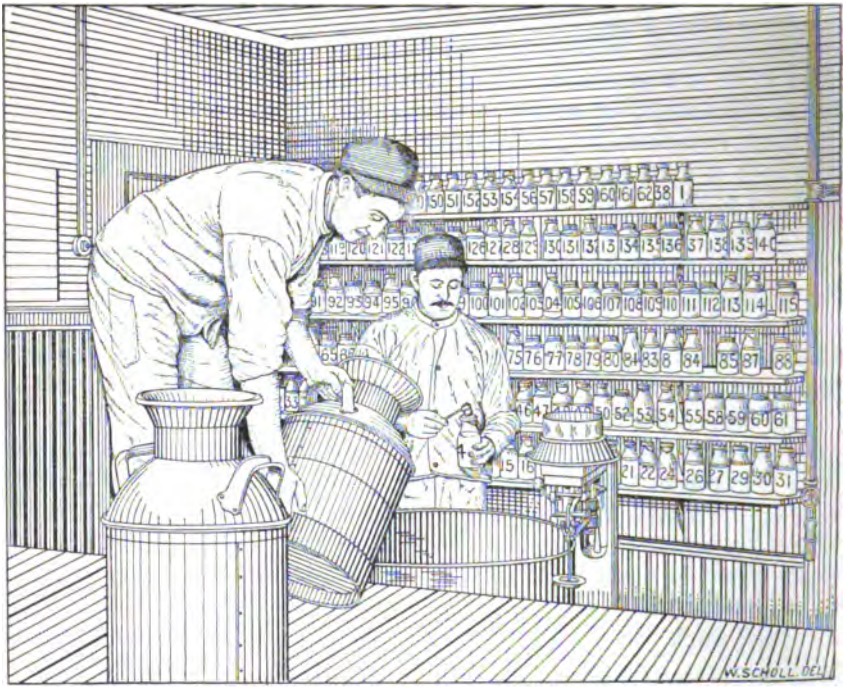

W. SCHOLL. DEL.

FIG. 1.—Receiving and sampling milk, college creamery, Iowa.

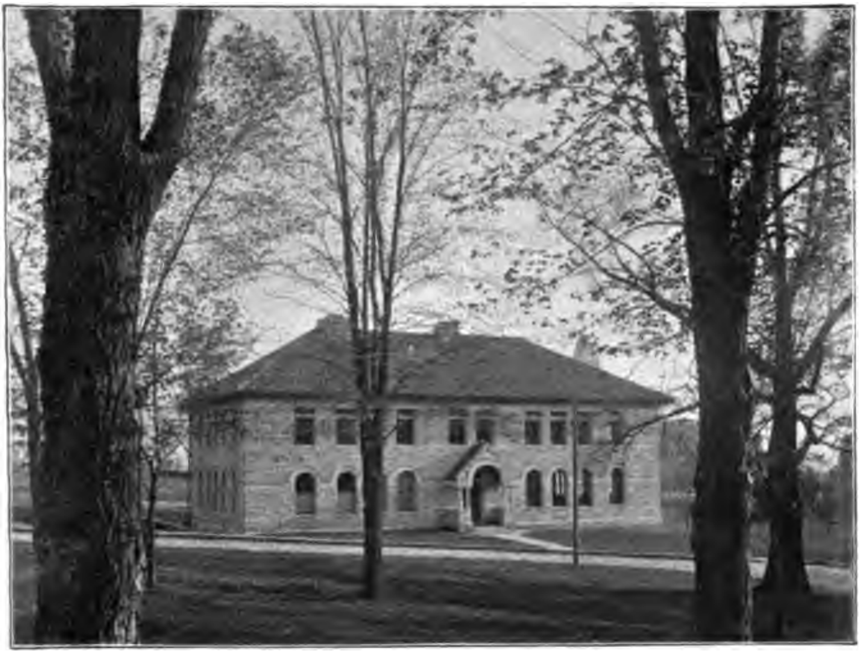


FIG. 1.—DAIRY HALL, NEW YORK.

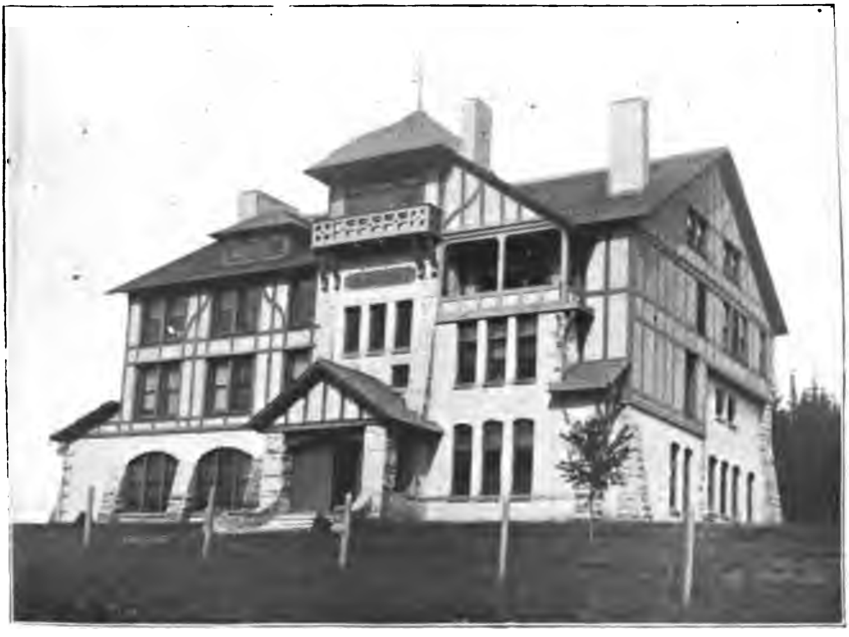


FIG. 2.—DAIRY HALL, WISCONSIN.

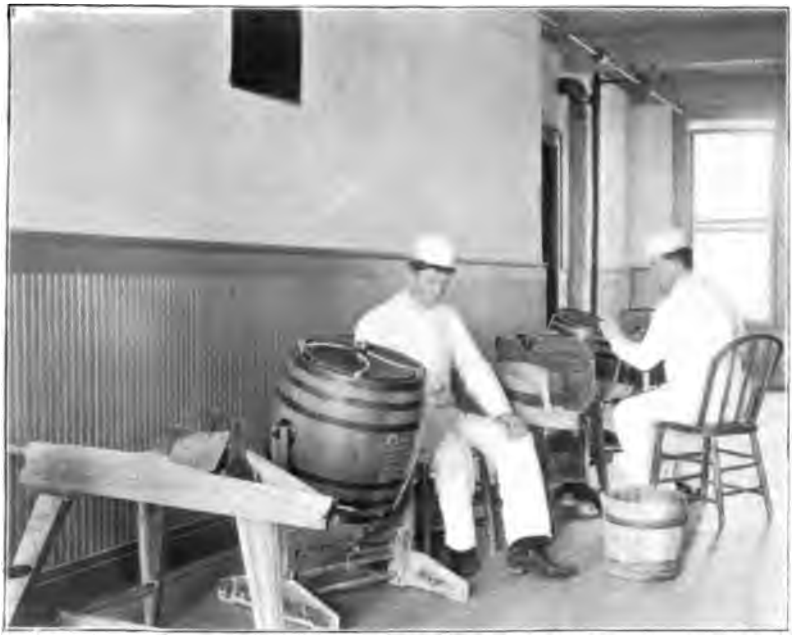


FIG. 1.—CHURNING ROOM, DAIRY SHORT COURSE, WISCONSIN.

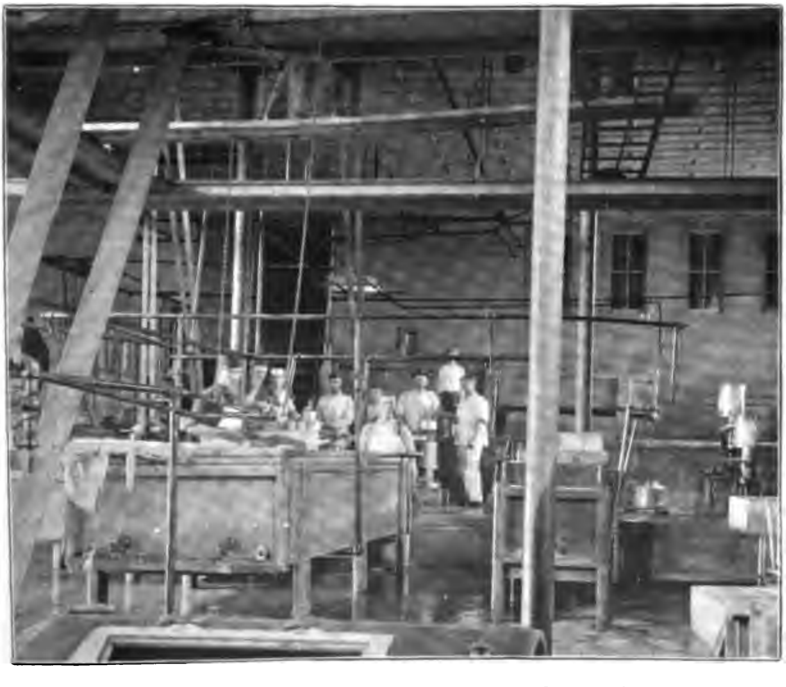


FIG. 2.—OPERATING SEPARATORS, CREAMERY COURSE, IOWA.

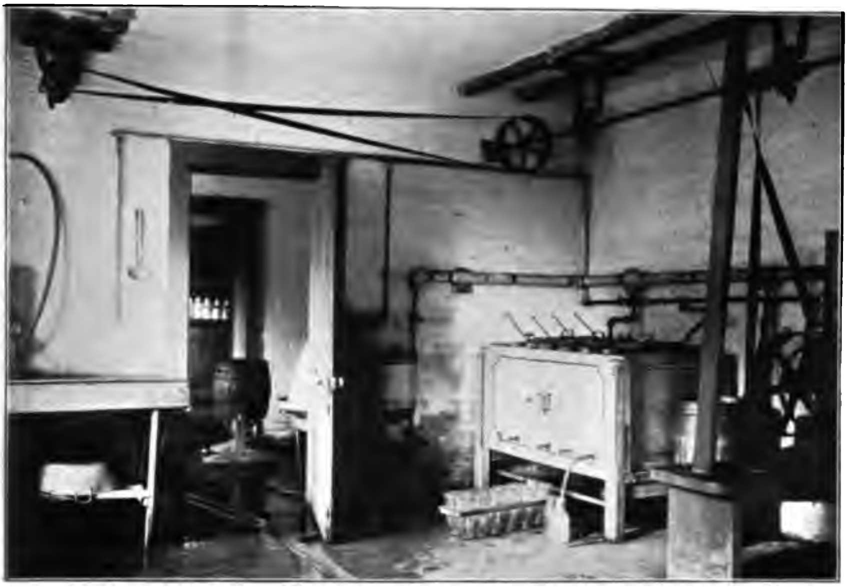


FIG. 1.—PASTEURIZING MILK, ILLINOIS.

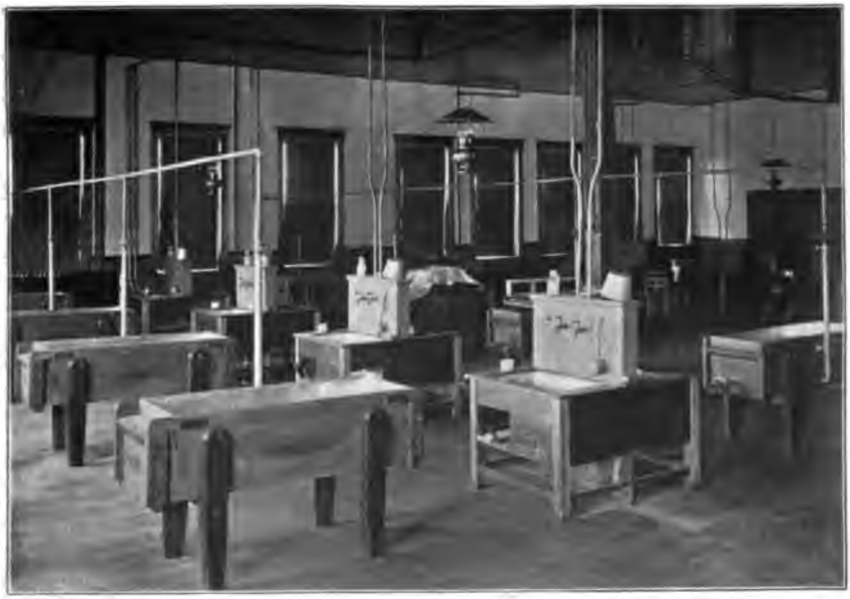


FIG. 2.—CHEESE ROOM, MINNESOTA.

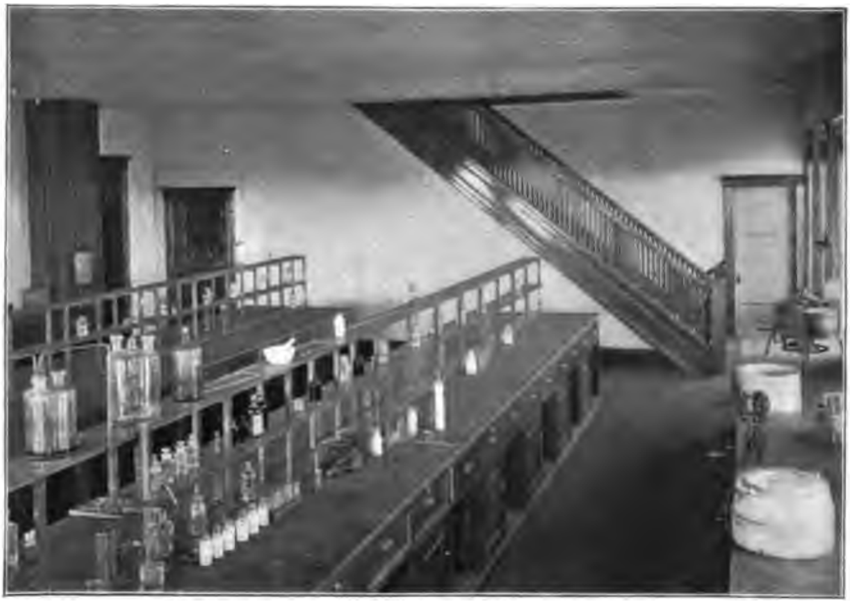


FIG. 1.—MILK LABORATORY, MINNESOTA.

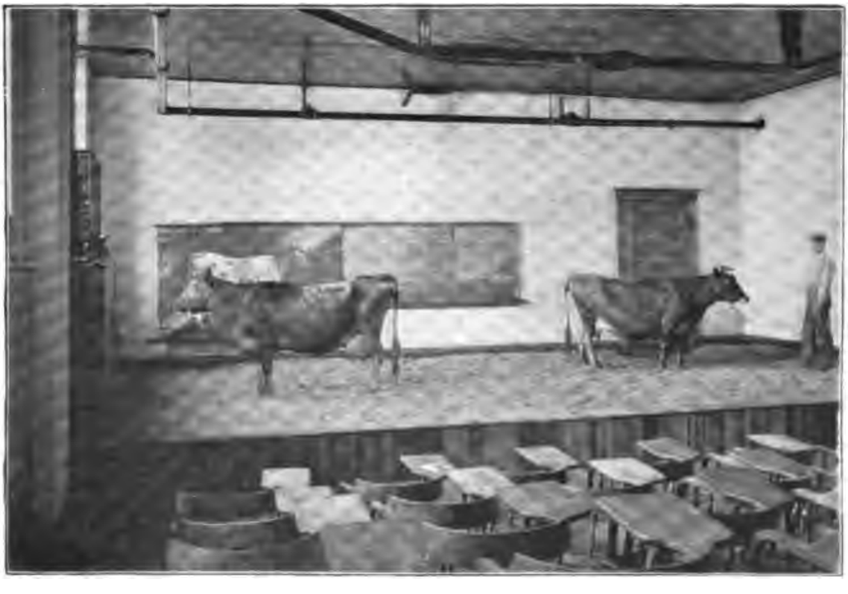


FIG. 2.—LIVE STOCK LECTURE ROOM. MINNESOTA

another room. The butter room (Pl. II) is fitted with all the apparatus necessary to make large or small amounts of butter—separators, cream ripening vats, churns, and butter workers, and usually different styles of each kind of machinery are in use, so that several squads can be working at the same time on the same kind of work, but with varied appliances. Each student changes from one kind of apparatus to another until he becomes familiar with all. Manufacturers frequently loan dairy machinery to the schools, thus getting a good opportunity to make their implements known, while the equipment of the school is increased and improved. In the cheese room (Pl. III, fig. 2) are found small cheese vats and all the accessories necessary in cheese making. In connection with this room is the curing room, where it is customary to keep careful record of the heat and moisture conditions throughout the term.

The laboratory (Pl. IV, fig. 1) resembles in many respects a chemical laboratory. Long benches are provided with drawers and closets, sinks, hot and cold water, and gas. Numerous testing machines run by direct steam jets, belt, and hand power are placed in the laboratory. Jars of sulphuric acid with rapid measuring arrangements for use in filling test bottles and apparatus for the acid tests and other experimental and chemical work have their place in this room. Each student keeps the glassware necessary for testing milk, cream, and skim milk in his own locker. Usually the lactometer and acid tests are used, and some of the earlier known rapid fat tests are sometimes shown. The reading room and library contain numerous dairy papers and books, herd books, etc. When special rooms are provided for instruction in farm dairying they are equipped with hand churns and separators, the conditions being made as near like those of a model farm dairy as possible. A special room is used for the engine and boiler, and instruction may here be given in firing, steam fitting, plumbing, and the care of the engine. (Pl. II, fig. 1.)

The lecture room is fitted with seats, having a wide folding arm rest suitable for holding a notebook. Blackboards and charts are on the wall for use in illustrating the lectures. A live stock lecture room (Pl. IV, fig. 2) is now in use in a few schools. It contains a large platform where animals can be brought in full view of the class and their peculiar and prominent points of excellence or failure discussed.

Schools not equipped with buildings as above described usually operate a creamery and perform all practical work in a building by itself, and conduct class-room work in other buildings. The fact that they have no costly structure is not evidence that they can not give good dairy instruction. (Pl. III, fig. 1.) (See fig. 2, text.)

Most dairy schools control herds of cows which furnish a part of their milk supply. In some cases these are pure bred, and the herd may contain animals of several different breeds; in other cases grade herds are kept with the intention of illustrating how a good herd can be built up from native stock at little or no more expense than is required to keep an ordinary herd with no improvement from year to year. The advantage of having cows of the best types, and medium good and poor animals, is evident.

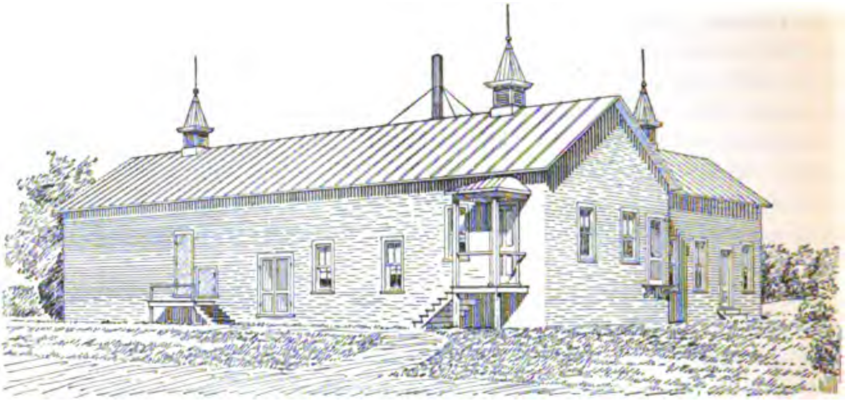


FIG. 2.—College creamery at Fargo, N. Dak.

Other facilities which aid in giving dairy instruction consist of college and experiment station libraries and farms well equipped with buildings and machinery, silos, feed cutters, grinders, and, frequently, electric power. The associations formed at dairy schools may become of great value long after the course is ended.

ADVANTAGES OF A DAIRY COURSE.

The benefits of a dairy course are so many that only a part of them can be mentioned here. The chief advantage of any kind of education is that it trains one to think. Dairymen should know *why* as well as *how*, and the one who understands the reasons for each of the steps in making dairy products is the one who most successfully meets unexpected and unfavorable conditions when they occur. Good operators who can think and who possess some original resources are wanted by creamery and cheese-factory managers. The latter are not slow to learn that an employee, understanding practical dairy work and capable of sound reasoning, is worth much more than the one who acts mechanically. If the skim milk or whey can be made to test one-tenth per cent less in butter fat, they want the man who can do it. There is a demand for good dairymen, and it is doubtful if many up-to-date butter makers or cheese makers can be found in the army of "educated unemployed;" such men are needed in too many places. The best students from the dairy schools are usually successful in securing first-class positions; in fact, the schools are sometimes unable to fill all the positions referred to them because of the lack of candidates.

Another benefit of special dairy training is, it makes one more independent. It frequently happens that the profits from a dairy concern can be much increased by changing the kind of product. If the butter market is depressed, it may be well to manufacture cheese for a time, or if the milk market is flooded, it will very likely be advantageous to the shipper or the dealer to make butter or cheese for a few days, until normal conditions of the market are resumed. This matter of being able to change at the right time may save many dollars' worth of milk which would otherwise be a total loss.

A great advantage of dairy schools is that they teach the same methods to all students, and in this way have much influence in making dairy products more uniform. Butter and cheese have been justly criticised for lack of this quality, but greater uniformity is already noticed as the result of dairy school training. Though several different lots of butter, alike except in minor particulars, may be equally good, they do not sell as well on the market as they would if more alike. When the makers in any section have been trained to ripen their cream in the same way, churn it at the same stage, use salt and color in the same degree, and pack the product in the same way, material benefits will accrue to all the creameries in that community.

From a financial standpoint a short dairy course may be regarded by an ambitious person who is much interested in dairying as a good investment. Many earnest men and women, limited in both time and money, have been able to help themselves very considerably by making the most of a few weeks at a dairy school. It must be remembered that tact and skill and keen interest in the work are necessary; without these the manager of a new and promising dairy enterprise may ruin it, but with them an ordinary place may be made to prosper and be a source of great profit to the community. Many run-down and struggling creameries are scattered through the country; often their unprosperous condition is due to a small supply of milk—this is beyond the control of the operator. But the trouble is sometimes in the factory itself, and in such a case an intelligent, energetic operator is usually the one thing needed.

A few cases may be cited showing how dairy schools have benefited individuals. A young man who had spent all his life at ordinary farm work and had very little knowledge of dairy methods took a ten weeks' creameryman's course and at its close obtained a position in a creamery paying $50 a month for ten months in the year. Before taking the course he had been getting $25 about eight months each year. Fifty dollars covered his entire expense at the school and by the outlay of this amount he more than doubled his income. The next winter he returned to the dairy school, heard the lectures a second time, repeated a part of the work, and took some advanced study. He then secured a position which paid him $55 per month with house rent free. The creamery of which this young man has charge has a neat, tidy appearance. He is agreeable to patrons and has the reputation of being the best creameryman in the community.

If one has had no practical experience in factory work he should endeavor to get at least one season's work as helper to a first-class maker. A man about 30 years of age had spent his life at general farm work. He decided to learn butter making and took a short dairy course, at the completion of which he became helper in a creamery at $27 a month. The next year he was butter maker in another creamery at a salary of $50 per month, and the next year, with one helper, he took charge of a large plant at a salary of $60 per month and free house rent. The beginning of this improvement was a determination to excel in dairy work, and the first act was to attend a short dairy course which cost, in all, about $50.

A young man who had just finished school attended a three months' dairy course at a total cost of nearly $75. The next summer he took full charge of a creamery receiving 12,000 pounds of milk a day, and besides making the butter kept the books and apportioned payments on the basis of fat delivered. His butter was awarded both first and second premiums in a close contest at the county fair. He was paid $65 a month. The next year he took full charge of a large creamery producing almost a ton of butter a day and had three assistants,—salary $80 per month.

Similar examples could be given of cheese makers receiving much help by a dairy school training and the marked success of young women could also be cited. At a recent Western State fair more than half the premiums on dairy products were taken by students holding dairy school certificates. These illustrations are given to show that a short scientific training in dairying can be made good use of by a practical person who wishes to learn more of creamery or cheese-factory work.

Special dairy training can be a means of just as great profit to the dairy farmer as to the factory operator. The butter produced on farms is far from perfect. As a rule, it sells for several cents less than the "best creamery," although some farmers receive the highest market price for their product. It is not an uncommon occurrence for two farmers living close together, having the same kind of stock and the same advantages for dairying, to differ 50 per cent in the profits from their herds. Lack of uniformity is a chief criticism of farm dairy butter. This is mainly due to different methods in the care of milk and cream and in making the butter, and defects resulting from the incompetency of the maker. The dairy school offers to the busy farmer or any member of his family a quick and cheap way of learning the best methods. The value of farm dairy butter should be materially increased; this can be easily done, and would mean many thousands of additional dollars to farmers. Farm dairy butter is often excellent in all points but one or two, which could be easily corrected. For example, it may not be well packed, though all right in other particulars; in such a case the use of a better package may raise the price a few cents per pound. Neat packages of well-made butter have been the means of lifting many mortgages.

Dairying has recently come to be regarded as the most profitable branch of agriculture in many localities where grain raising or general farming had been the leading occupation and farmers have been compelled to give their chief attention to their herds. Those who have not been in the business long, or have never put their best effort into it, little appreciate the great losses due to poor methods in feeding, selecting, and caring for stock and preparing the product for market. It has been shown repeatedly that one cow may easily produce twice the butter of another, making her profit more than double the profit from the poor cow. The lectures and practical work on selecting, judging, and managing stock give valuable instruction on these matters. It is claimed that the fat which remains in the skim milk and buttermilk on farms would increase the yield of farm dairy butter 25 per cent if it could be saved. Nearly all of this can be saved by the careful practice of modern methods.

ADVANTAGES OF DAIRY SCHOOLS TO THE PUBLIC.

Dairy schools are a benefit to the public as well as to the few individuals who attend them for instruction. In countries where they have been in operation for many years this is very evident, and in parts of this country the benefits may already be seen. Each school becomes a center for advanced dairy thought and each successive year, as class after class goes out, its influence is widened. Every student carries new ideas to his home, and though some may make little use of the training others will make much of it, both in their own work and in helping their neighbors. The creamery or cheese-factory operator occupies a peculiar place in the community; he is in a position to do much more than simply receive milk from the patrons and manufacture the product. If he understands the care and feeding of cows, the compounding of rations, value of manures, and, especially, the proper care of milk before its delivery at the factory, his advice on these things is of great value to the farmers whom he meets daily. The more the influence of these schools can be spread the greater will be their good to the public. Besides the community in which they are located, they benefit distant consuming communities by improving and cheapening dairy products.

If the money expended in the support of dairy schools is well used, a small amount of it is capable of doing great good. Many schemes have been proposed for aiding schools in the instruction of dairymen. In England traveling dairy schools have been tried with some success.

Dairymaids are sent out to remain on a single farm several days, teaching the best methods of conducting the dairy with whatever appliances may be at hand. With some persons sufficient interest is aroused to lead them to take a short course at a dairy school. This system of instruction could be followed with profit in parts of this country, especially in the outlying districts. If means were available, capable instructors might be advantageously employed for the entire year, spending the winter at dairy schools and the remaining months in the field. Valuable service for the State could be rendered by visiting farms and factories and showing in each place how the best product can be made under the conditions furnished. It is an excellent plan for dairy school instructors to visit their students after the completion of the course, when they have taken up practical work, to aid them in putting into practice the ideas gained at the school and to see if conditions exist which permit successful work.

The importance of instruction in farm dairying is very great. About 85 per cent of the butter produced in this country is made on farms, and as the quality of our dairy products as a whole can not be much improved until this large proportion shows improvement, the need is very evident of offering every inducement to learn to those who make butter in small amounts on the home farm. Several agencies have been used to supplement the efforts of the dairy schools in this line. Dairy conferences have been held in this country and good results thus accomplished. Courses of reading similar to the Chautauqua courses have been started; these might be directed from the dairy schools. Systematic instruction can also be given by correspondence.

APPENDIX.

Brief statements follow, showing the facilities for instruction in dairying now offered in the several States. Some schools receive generous support from the States in which they are located, and have everything necessary to enable them to do much good work. In other States the equipment is not on an elaborate scale; in a few there are no dairy schools, as there seems to be no demand for them. When the need for widespread education in dairy lines is better understood and the good results which accrue from such education are better appreciated, even more facilities for instruction will be offered than is the case to-day.

In the statements following, the names and locations of the different schools are given, together with the officers in charge and the proper officials to address for further information. The different courses of study which are offered are briefly described, the approximate cost of these courses stated, and certain features of the equipment referred to. In States where a large number of people are interested in dairying the classes at the dairy schools are usually large, and there is a correspondingly large force of instructors; some schools have been obliged to refuse admission to applicants on account of lack of room.

When one has concluded to attend a dairy school it is not always an easy matter to decide where to go. The school in his own State would be the natural place to choose, as it probably makes a specialty of the kind of dairying most practiced in that State. Each school naturally has the interests of its own State uppermost; for example, if cheese making is prominent in a certain State, that branch of the industry is likely to receive special attention at the dairy school of that State. If it is decided to attend a school in another State, the list following may be consulted, and when a few are found that seem to meet the requirements, their circulars should be obtained for further information:

ALABAMA.

Agricultural and Mechanical College of Alabama, Auburn.

[William Leroy Broun, M. A., LL. D., president; J. F. Duggar, M. S., professor of agriculture.]

For full information concerning dairy instruction, address Prof. J. F. Duggar, Auburn, Ala.

A regular short dairy course is not offered. A person desiring instruction in farm dairy work can spend the fall term of three months at the college and take dairying and allied subjects.

Cost: Fees, $6; board and room, per week, $2.50. (No uniform required.)

Equipment: A creamery, hand separator, and outfit for making butter in small quantities.

Other facilities: Experiment station and neighboring dairy herds.

Tuskegee Normal and Industrial Institute (incorporated), Tuskegee.

[Booker T. Washington, principal; J. H. Washington, superintendent of industries.]

For full information concerning dairy instruction address Prof. J. W. Hoffman, Tuskegee, Ala.

This institution is established for the education of colored young men and women. A course of eight months is offered in farm dairying, beginning early in September. Instruction is given by lectures and practical work. The lectures treat of milk, butter making, dairy chemistry and bacteriology, and dairy cattle.

Cost: Tuition (for dairy course), free; board and room, per week, $2.25.

Equipment: A dairy building, well equipped for practical farm dairy work, testing of milk, butter making, etc.

Other facilities: Herd of pure bred and grade Jersey cattle.

ARIZONA.

University of Arizona, Tucson.

[Howard Billman, M. A. president; William Stowe Devol, B. Agr., professor of agriculture.]

For information concerning dairy instruction, address Prof. William S. Devol, Tucson, Ariz.

No regular short dairy course is offered; some dairy instruction is given, however, in the regular agricultural course. A person can attend for a brief period and receive instruction in dairying any time during the session of the university by making special arrangements with the professor of agriculture.

Cost: Tuition, free; board and room per week, $4.

Equipment: Facilities for making butter and cheese.

ARKANSAS.

Arkansas Industrial University, Fayetteville.

[J. L. Buchanan, M. A., LL. D , president; R. L. Bennett, M. S., superintendent of agriculture.]

For full particulars concerning dairy instruction, address Prof. R. L. Bennett, Fayetteville, Ark.

A regular short dairy course is not offered, but instruction in dairying may be taken for a brief period in the winter term by making special arrangements with the professor of agriculture.

Cost: Tuition, free; board and room per week, $3.

Equipment: All necessary appliances for conducting a modern dairy.

CALIFORNIA.

College of Agriculture and University of California, Berkeley.

[M. Kellogg, LL. D., president; E. W. Hilgard, Ph. D., LL. D., professor of agriculture.]

For full particulars concerning dairy instruction, address Prof. E. J. Wickson, Berkeley, Cal.

A special dairy course is not offered. A course of three lectures per week, beginning the middle of August and continuing six months, treats of stock breeding and dairy husbandry. This is given in connection with a lecture and laboratory course in dairy feeding. A laboratory course in the chemistry of milk and dairy products is also given. Special students who are qualified to carry out the work are taken for any period.

Cost: Laboratory fee per annum, $10; board and room per month, $20.

Equipment: Laboratory fully equipped for analyses of dairy products and feeding materials and with apparatus for milk testing. Growth of forage plants adapted to arid conditions.

COLORADO.

The State Agricultural College of Colorado, Fort Collins.

[Alston Ellis, M. A., Ph. D., LL. D., president; W. W. Cooke, B. S., M. A., professor of agriculture.]

For full particulars concerning dairy instruction, address Prof. W. W. Cooke, Fort Collins, Colo.

Instruction in butter making in small amounts is given in the short course of agriculture. Any person can receive instruction in milk testing at any time.

Cost: Tuition, free; board and room per week, $3.

Equipment: Deep-setting apparatus, hand separator, and appliances for making butter in small lots. Efforts are being made to have a building erected suitable for giving instruction in creamery work.

Other facilities: A herd of cows supplies part of the milk used.

CONNECTICUT.

Storrs Agricultural College, Storrs.

[B. F. Koons, Ph. D., president; C. S. Phelps, B. S., professor of agriculture.]

For full information concerning dairy instruction, address Prof. C. S. Phelps, Storrs, Conn.

A short dairy course is not offered, but special students are admitted during the winter term of twelve weeks, and can put all their time on dairying and allied subjects if they so elect. Twenty lectures are given on dairy farming, the composition and testing of milk, manufacture of butter and cheese, and the preparation of milk and cream for market. The practical work consists of testing milk, separating milk by gravity and centrifugal methods, and butter making.

Cost: Tuition, free; board and room per week, $3.

Equipment: One thousand five hundred dollars have recently been appropriated for new dairy machinery, and complete modern apparatus for giving instruction as outlined will be purchased. A complete dairy building is in process of construction, the creamery wing of which will be ready for use in January, 1897.

Other facilities: One thousand eight hundred dollars have been appropriated for the purchase of thoroughbred stock.

DELAWARE.

Delaware College, Newark.

[George A. Harter, M. A., Ph. D., president; W. H. Bishop, B. S., professor of agriculture.]

For information concerning dairy instruction, address Prof. W. H. Bishop, Newark, Del.

No regular short course in practical dairying is offered. Some dairy instruction is given by lectures in the agricultural course, and any person so desiring can take this work with other agricultural subjects in the short winter course.

Laboratory instruction in the use of the Babcock tester is also given.

Cost: Tuition, free; board and room per week, $3.50.

Equipment: Babcock tester.

FLORIDA.

In Florida no instruction in dairying is offered at the State Agricultural College, located at Lake City.

GEORGIA.

Georgia State College of Agriculture and Mechanic Arts, Athens.

[H. C. White, Ph. D., president; J. B. Hunnicutt, B. A., professor of agriculture; H. J. Wing, instructor in dairying.]

For full particulars concerning dairy instruction, address H. J. Wing, Athens, Ga.

A regular short dairy course of two to three weeks in March is offered, and students desiring special instruction in milk testing or butter or cheese making are admitted at any time.

Cost: Tuition, free; board and room per week, $2.50.

Equipment: A dairy building is fitted with the necessary apparatus for the work outlined.

IDAHO.

College of Agriculture of the University of Idaho, Moscow.

[F. B. Gault, M. S., president; C. P. Fox, M. Agr., professor of agriculture.]

For information concerning dairy instruction, address Prof. C. P. Fox, Moscow, Idaho.

Dairy course: A six weeks' course in farm dairy work commences early in November.

Cost: Tuition, free; board and room per week, $3.50.

Equipment: Power and apparatus necessary for making butter and testing milk.

INDIANA.

School of Agriculture, Horticulture, and Veterinary Science of Purdue University, Lafayette.

[James H. Smart, M. A., LL. D., president; William C. Latta, M. S., director of the school of agriculture; C. S. Plumb, B. S., professor of animal industry and dairying.]

For full information concerning dairy instruction, address Prof. W. C. Latta, Lafayette, Ind.

Dairy course: An eleven weeks' course in farm dairying commences early in January. It is given in connection with other lines of agricultural instruction. The daily work consists of lectures on dairy subjects followed by practice in the dairy.

Students entering this course must be at least 16 years of age.

Cost: Students from Indiana, tuition, free; students from other States, tuition, $10; deposit for breakage (returnable), $2; incidental fee,* $10; board and room, per week, $2.50.

Equipment: A dairy building of five rooms is furnished with a complete outfit for making butter and cheese and for testing milk.

ILLINOIS.

College of Agriculture of the University of Illinois, Urbana.

[Andrew S. Draper, LL. D., president; Eugene Davenport, M. Agr., professor of animal husbandry and dean, W. J. Fraser, instructor in dairying.]

For full information concerning dairy instruction, address Prof. Eugene Davenport, Urbana, Ill.

Dairy course: The department of dairying has recently been established. A short course in farm dairying will be offered commencing early in January. Instruction will be given in testing and pasteurizing milk and cream, and making butter in small amounts.

---

* Two scholarships are offered each county agricultural society, farmers' institute, F. M. B. A., grange, etc., and the persons to whom these are granted are exempt from the incidental fee of $10.

Cost: Tuition, free; board and room per week, $3.

Equipment: The dairy building contains a small engine and boiler, pasteurizer and apparatus for making butter in small churnings, and arrangements for handling milk for city trade.

IOWA.

Iowa State College of Agriculture and Mechanic Arts, Ames.

[W. M. Beardshear, M. A., LL. D., president; James Wilson, professor of agriculture; G. L. McKay, instructor in dairying.]

For information concerning dairy instruction, address Prof. James Wilson, Ames, Iowa.

Courses: (*a*) An eight weeks' winter school in dairying commences early in January. It is planned for those who wish to make a specialty of dairying, and is mostly attended by men who have had practical experience in dairy work. Six half days per week are spent in practical work in the butter and cheese departments; class-room instruction is given by daily lectures on dairy operations, chemistry, bacteriology, and bookkeeping.

(*b*) and (*c*) Two summer schools of dairying begin, respectively, in February and July, and continue sixteen weeks. Instruction covers the same ground that is gone over in the winter course, but as the term is longer the different parts of the work can be taken up in greater detail; some experimental work is conducted.

(*d*) A one year's course is offered, and students successfully completing it are given certificates.

Cost: Tuition, free; board and room per week, $3.50; two white suits, $2.

Buildings: The dairy instruction is given in a building fitted as a large creamery, which is operated throughout the year. A cheese room, laboratory, class room, dressing room, and dwelling apartments are in the same building.

Equipment: The building is fitted with the necessary apparatus for making butter and cheese in large or small amounts and for testing milk.

Other facilities: A herd of cows representing six different breeds of cattle is kept on the farm and stabled in a building fitted with the latest improvements for dairy barns.

KANSAS.

Kansas State Agricultural College, Manhattan.

[George T. Fairchild, LL. D., president; C. C. Georgeson, M. S., professor of agriculture.]

For information concerning dairy instruction, address President George T. Fairchild, Manhattan, Kans.

No regular short course in dairying is offered. Instruction in the theory and practice of making butter in small amounts is given for ten weeks each spring term to the young women in the second year of the regular agricultural course.

Equipment: Deep and shallow setting apparatus for raising cream and appliances for making butter in small amounts.

KENTUCKY.

Agricultural and Mechanical College of Kentucky, Lexington.

[J. K. Patterson, Ph. D., president; C. W. Mathews, B. S., professor of agriculture; M. A. Scovell M. S., lecturer on dairying.]

For full information concerning dairy instruction, address Prof. C. W. Mathews, Lexington, Ky.

Dairy course: Instruction in farm dairying is given in connection with the regular eight weeks' short course in agriculture, beginning early in January. The field of dairying is covered briefly by lectures; the practical work consists of fifteen 2-hour hour exercises in testing milk and making butter and cheese.

Cost: Tuition, residents of Kentucky, free; room and board per week, $3.

Equipment: A dairy house has recently been erected and fully equipped for experimental work in handling milk and making butter and cheese.

Other facilities: A herd of cows on the college farm.

LOUISIANA.

In Louisiana no instruction in dairying is offered at the State Agricultural College, located at Baton Rouge.

MAINE.

Maine State College, Orono.

[Abram W. Harris, M. A., D. Sc., president; Charles D. Woods, B S., professor of agriculture.]

For full information concerning dairy instruction address Prof Charles D. Woods, Orono, Me.

Dairy course: A six weeks' course in dairying is offered, commencing in January. It is designed for those who wish to become expert butter or cheese makers. If it is pursued two terms, and two seasons' satisfactory work is performed in a butter or cheese factory, the student will be granted a certificate of proficiency Practical work is conducted each afternoon; in the mornings lectures are given on dairy cattle, dairy products and operations, care of boilers, diseases of cattle, and business law.

Cost: Tuition, free; board and room per week, $3.50; two white suits, $2

Equipment: A building especially constructed for instruction in dairying is fitted with modern dairy appliances for testing milk and making butter and cheese.

MARYLAND.

Maryland Agricultural College, College Park.

[R. W. Sylvester, president; W. T L. Taliaferro, professor of agriculture.]

For information concerning dairy instruction, address Prof. H. J Patterson, College Park, Md.

No regular short dairy course is offered. Instruction in dairying is given to the agricultural students and twelve weeks of work in general dairy lines is offered to others each winter.

Cost: Tuition, $5; board and room per week, $5.

Equipment: A newly equipped dairy building.

MASSACHUSETTS.

Massachusetts Agricultural College, Amherst.

[Henry H. Goodell, LL. D., president; William P. Brooks, B. S., professor of agriculture.]

For full information concerning dairy instruction, address Prof. William P. Brooks, Amherst, Mass.

Dairy course: (*a*) An eleven weeks' course in creamery work commences early in January. Lectures are given on the principles of dairy farming, breeding and management of cattle, cattle diseases, stable construction, bookkeeping, composition of milk, pasteurization, milk testing, and butter making. Practical creamery work is conducted.

Applicants for this course must be 16 years of age or over.

Cost: Tuition to citizens of the State, free; laboratory fees, cost of materials; board and room per week, $3.75; two white suits, $2.

(*b*) A course in farm dairying is conducted at the same time in connection with the short winter course in agriculture.

Equipment: A wing of the barn, containing several rooms, has been fitted with modern machinery for practical and educational work in dairying as above outlined. Power is furnished by an electric motor.

Other facilities: A herd of selected grade cows is being bred with especial attention to their dairy qualifications; museum of illustrative material; agricultural library.

MICHIGAN.

Michigan Agricultural College, Agricultural College.

[J. L. Snyder, Ph. D., president; Clinton D. Smith, M. S., professor of agriculture.]

For full information concerning dairy instruction, address Prof. C. D. Smith, Agricultural College, Mich.

Dairy course: A six weeks' course in farm dairying is offered. The course begins early in January. Instruction is given by lectures and practical work, special attention being given to chemistry of milk, butter making, and stock judging and feeding. Practical butter making is conducted six half days each week and work at the barn mornings and afternoons.

Equipment: The basement of the experiment station building is fitted up for butter making in small amounts. Studies in bacteriology and chemistry are conducted in fully equipped laboratories.

Other facilities: A herd of cows representing eight different breeds is on the college farm; various forms of silos, stalls and fixtures are in operation

MINNESOTA.

College of Agriculture of the University of Minnesota, Minneapolis.

[Cyrus Northrup, LL. D., president; William M. Liggett, dean. School of Agriculture, St. Anthony Park, Henry Webb Brewster, Ph. D., principal; T. L. Haecker, professor of dairy husbandry, in charge of dairy school.]

For full information concerning dairy instruction, address Prof. T. L. Haecker, St. Anthony Park, Minn.

Dairy courses: (*a*) A four weeks' course, commencing early in January, is designed for butter and cheese makers who have had at least one season's experience in factory work. The course consists of sixty lectures on the various branches of dairying and closely allied subjects. The practical work consists of the making of butter in small and large amounts, manufacture of cheese, including the Swiss, brick, Edam, and Gouda varieties, methods of testing milk, scoring butter and cheese, and practical engineering. Each morning is given to lectures and all afternoons to practical work.

Certificates of proficiency will be given to students who show themselves after two terms' work at the school and two seasons' practical work in cheese factory or creamery to be efficient in factory or creamery work.

Cost: Registration fee, $15; board and room per week, $3.50; two white suits, $2.

(*b*) Instruction in farm dairying is given in a short special course in agriculture. Lectures and practical work are given twice a week for sixteen weeks.

(*c*) A six weeks' course in early summer is offered to women, dairying and other subjects being given. The only expense of this course is $3.50 per week for board.

Buildings: Dairy Hall, specialy erected for this purpose, is a large building containing rooms for instruction in butter and cheese making, pasteurizing and testing milk, also lecture rooms, reading room, and dressing rooms.

Equipment: Complete and modern appliances and machinery necessary to the courses of instruction described.

Other facilities: A large herd representing three different breeds and the best types of grade dairy stock supplies part of the milk used at the school.

MISSISSIPPI.

Mississippi Agricultural and Mechanical College, Agricultural College.

[S. D. Lee, president; W. C. Welborn, M. S., professor of agriculture.]

For information concerning dairy instruction, address Prof. W. C. Welborn, Agricultural College, Miss.

A regular short dairy course is not offered, but instruction in dairying is given in the agricultural course. Work in the creamery is offered to any desiring it, who make special arrangements with the professor of agriculture.

Cost: Tuition, free; board and room per week, $2.

Equipment for giving dairy instruction consists of a regularly equipped creamery and large herd of dairy cows.

MISSOURI.

College of Agriculture and Mechanical Arts of the University of Missouri, Columbia.

[R. H. Jesse, LL. D., president; H. J. Waters, B. Agr., dean; F. B. Mumford, M. S., professor of agriculture.]

For full information concerning dairy instruction, address Prof. H. J. Waters, Columbia, Mo.

A special course in dairying is not offered. Three weeks of practical work in farm dairying is given in connection with the twelve weeks' winter course in agriculture, which begins early in January. A person can attend for these three weeks only if he is unable to take the complete short course. The dairy instruction consists of twenty lectures, supplemented by practical work in the care of milk and butter making. With the dairy work, subjects allied to dairying may also be taken, as lectures on stock breeding and feeding, selection and management of a dairy herd, dairy chemistry, and bacteriology.

Applicants must be 16 years of age or older.

Cost: Laboratory fee, $5; board and room per week, $3.50.

Equipment: A dairy building is equipped with Babcock testers, apparatus for pasteurizing milk and cream, and different styles of hand-power machinery for separating milk and making butter.

Other facilities: A herd of twenty thoroughbred Jersey cows is kept for illustration and practice in judging dairy cattle.

MONTANA.

The Montana College of Agriculture and Mechanic Arts, Bozeman.

[Rev. James Reid, B. A., president; Frank Beach, B. S., professor of agriculture.]

For information concerning dairy instruction, address President James Reid, Bozeman, Mont.

No regular short course in dairying is offered. Some dairy instruction is given, however, in the agricultural course, and arrangements can be made to attend for this instruction for a brief period between September and June.

Cost: Entrance fee, $10; board and room per week, $4.

NEBRASKA.

The Industrial College of the University of Nebraska, Lincoln.

[George E. MacLean, Ph. D., LL. D, chancellor; Charles E. Bessey, Ph. D., dean; T. Lyttleton Lyon, B. S. A., professor of agriculture; A. L. Haecker, instructor in dairying.]

For full information concerning dairy instruction, address Prof. T. L. Lyon, Lincoln, Nebr.

Dairy course: A twelve weeks' course in farm dairying is offered, commencing early in January. Instruction will consist of lectures on dairy methods and closely allied subjects, supplemented by practical work in butter making and milk chemistry.

Cost: Fee, $1; board and room per week, $2.75; white suits, $2.

Equipment: A dairy house has just been completed; it contains a large work room and two class rooms. Apparatus consists of hand separators, deep-setting cans, and necessary utensils for making butter as in a home dairy.

NEVADA.

School of Agriculture of the Nevada State University, Reno.

[Joseph E. Stubbs, M. A., D. D., LL. D., president; R. H. McDowell, B. S., professor of agriculture.]

For information concerning dairy instruction, address Prof. R. H. McDowell, Reno, Nev.

No regular dairy course is offered. Some dairy instruction is given by lectures in the agricultural course, and practical work with the Babcock tester is also given. Arrangements can be made to attend for twelve weeks in the fall to receive instruction by lectures and practical work in a creamery.

Cost: Tuition, free; board and room per week, $4.00; two white suits, $2.00.

Equipment: A Babcock tester and use of a public creamery at Reno.

NEW HAMPSHIRE.

New Hampshire College of Agriculture and the Mechanic Arts, Durham.

[C. S. Murkland, M. A., Ph. D., president; Charles H. Pettee, M. A., C. E., dean; F. William Rane, B. Agr., M. S., professor of agriculture.]

For information concerning dairy instruction, address President Charles S. Murkland, Durham, N. H.

Dairy courses: A course in creamery and farm dairy work extends throughout the winter term for regular students in the college, and any four continuous weeks thereof for special students. Instruction is given by lectures, demonstrations, and practical work. Dairy husbandry, milk testing and pasteurizing, butter making, dairy bacteriology, dairy engineering, and the care of animals receive special attention. Certificates are granted upon the satisfactory completion of the term's work.

Cost: Fee, $5; board and room per week, $4; two white suits, $2.

Equipment: A creamery building is fitted with various styles of apparatus necessary for making butter and pasteurizing and testing milk.

Other facilities: A herd on the college farm contains typical animals of four different breeds and grades.

NEW JERSEY.

Rutgers Scientific School, the New Jersey State College for the Benefit of Agriculture and the Mechanical Arts, New Brunswick.

[Austin Scott, Ph. D., LL. D., president; E. B. Voorhees, M. A., professor of agriculture.]

For information concerning dairy instruction, address Prof. E. B. Voorhees, New Brunswick, N. J.

A special short dairy course is not offered. Instruction in dairying is given in the regular agricultural course.

Equipment: A dairy house fitted with modern dairy apparatus, and a laboratory fitted for testing dairy products.

NEW MEXICO.

In New Mexico no instruction in dairying is offered at the State College, located at Mesilla Park.

NEW YORK.

College of Agriculture of Cornell University, Ithaca.

[Jacob G. Schurman, D. Sc., LL. D., president; Isaac P. Roberts, M. Agr., professor of agriculture and dean; H. H. Wing, M. S., professor of animal industry and dairy husbandry.]

For information concerning dairy instruction, address Prof. I. P. Roberts, Ithaca, N. Y.

Dairy courses: (*a*) A winter dairy course of eleven weeks is offered, commencing early in January. It is especially designed to meet the needs of creamery and cheese factory men who desire more thorough instruction and to train those who expect to make butter and cheese making a profession. One lecture on dairying is given throughout the course, at 8 o'clock each morning. The management of the dairy and the operations in butter and cheese making are explained, the business management of the factory, dairy mechanics, and the care and breeding of cattle are discussed; from 9 to 10 o'clock various subjects more or less intimately related to dairying are discussed. At 10 o'clock each morning practical work is commenced, being so arranged that each student spends two days a week on each branch, viz, butter making; cheese making; and milk testing, problems, and bookkeeping. Certificates of proficiency are awarded to all who successfully complete the dairy course and one full season at an approved creamery, cheese factory, or dairy.

Applicants must be at least 17 years of age and possess a common school education.

Cost: Fee, $15; deposit to cover breakage (returnable), $4; board and room per week, $3.50; two white suits, $2.

(*b*) Instruction with special reference to the needs of the farm dairy is given in connection with the winter course of agriculture.

Buildings· A building was erected in 1893 especially for instruction in dairying and can accommodate 50 students. It contains an engine room, rooms for instruction in butter and cheese making, laboratories for milk testing, and special work; also a large lecture room, reading room, and dressing rooms.

Equipment: Various styles of all modern dairy appliances and power necessary for their operation.

Other facilities: A herd representing three different breeds and containing some high-grade animals furnishes part of the milk used at the school.

NORTH CAROLINA.

The North Carolina College of Agriculture and Mechanic Arts, Raleigh.

[Alexander Q. Holladay, president; B. Irby, M. S., professor of agriculture.]

For full information concerning dairy instruction, address Prof. B. Irby, Raleigh, N. C.

A regular dairy course is not offered, but special instruction in testing milk and making butter and cheese in small amounts is given to any who apply for it during the session.

Cost: Tuition, per month, $2; board and room per week, $2.50.

Equipment: A dairy building fitted with apparatus for testing milk and making butter.

NORTH DAKOTA.

North Dakota Agricultural College, Fargo.

[J. H. Worst, president; J. H. Shepperd, M. S. A., professor of agriculture; E. E. Kaufman, professor of dairying.]

For full particulars concerning dairy instruction, address President J. H. Worst, Fargo, N. Dak.

Dairy course: (*a*) A course of twelve weeks, beginning early in January, is offered to any who desire to become more proficient in creamery work. Lectures are given on the principles of dairying, including the handling of milk, manufacture of butter and cheese, chemistry and bacteriology of the dairy, and management of cattle.

Cost: Tuition, free; board and room per week, $3; fees, $5.

(*b*) A one year's course is designed to meet the requirements of those who have had no previous experience in creamery work. The entire field of practical dairying is covered in the course, which includes careful training in all the details of management of a creamery or farm dairy.

Cost: Tuition, free; board and room per week, $3; fees, $5.

Equipment: A model creamery, with cheese room attached, is equipped with power and all the apparatus necessary either to a creamery or cheese factory. Accommodations are limited to twelve students.

OHIO.

Ohio State University, Columbus.

[James H. Canfield, LL.D., president. College of Agriculture, Thomas F Hunt, M. S., dean; H. J. Noyes, assistant professor of dairy husbandry.]

For full information concerning dairy instruction, address Prof. William R. Lazenby, Columbus, Ohio.

Dairy courses: An eleven weeks' course in dairying begins each year, early in January. Butter making, as practiced in the creamery and farm dairy, is thoroughly taught. The principles of cheese making are given, together with some elementary practice. Instruction by lectures includes dairy cattle and their management, manufacture of dairy products, dairy chemistry and bacteriology, and the care of the engine.

Candidates for admission must be at least 15 years of age. Those under 21 must pass an examination in grammar, geography, arithmetic, and United States history.

Cost · Fees, $15; room and board per week, $3; two white suits, $2.

Equipment. The dairy laboratory and work room is situated in the basement of Chemical Hall. It is well supplied with modern appliances for testing milk and the manufacture of butter and cheese.

Funds for the erection of an agricultural hall have recently been appropriated, and liberal provision will be made in the new building for dairy instruction It is hoped to have it ready for occupancy in 1898.

Other facilities: A dairy of thirty cows, and a large farm equipped for investigations in stock feeding.

OKLAHOMA.

Oklahoma Agricultural and Mechanical College, Stillwater.

[G. E. Morrow, M. A., president and professor of agriculture.]

For full information concerning dairy instruction, address President G. E. Morrow, Stillwater, Okla.

A special dairy course is not offered. Instruction in dairying is given, however, in the regular course of agriculture, and one can attend for a period of six weeks during the winter term by making special arrangements. Work consists of milk testing, butter making and cattle feeding.

Cost: Tuition, free; board and room per week, $3.

Equipment: A small dairy room fitted with butter-making and milk-testing apparatus; there are also some facilities for work in bacteriology.

OREGON.

Oregon State Agricultural College, Corvallis.

[H. B. Miller, president; H. T. French, M. S., professor of agriculture; F. L. Kent, B. S. A., instructor in dairying]

For full information concerning dairy instruction, address Prof. H. T. French, Corvallis, Oreg.

Dairy course: Instruction in farm dairying is given in connection with the farmers' short course, which commences early in January and continues four weeks.

Cost: Tuition, free; room and board per week, $2.50.

Equipment: A dairy building is furnished with tester, separator, and appliances for making butter in small amounts.

Other facilities are furnished for studying and judging dairy stock; three breeds are represented in the college herd.

PENNSYLVANIA.

The Pennsylvania State College, State College.

[George W. Atherton, LL. D., president. School of Agriculture, Henry Prentiss Armsby, Ph. D., dean; Harry Hayward, B. S., instructor in dairy husbandry.]

For information concerning instruction in dairying, address "The Dean of the School of Agriculture," State College, Center County, Pa.

Dairy courses: (*a*) A creamery course opens early in January and continues six weeks. It is designed for those especially interested in the manufacture of butter in creameries. Forty-eight lectures are given on butter making, dairy chemistry and bacteriology, dairy bookkeeping, breeding, feeding, care and diseases of dairy stock, and the management of dairy machinery. Practical butter making on a creamery scale is a daily exercise.

(*b*) A private dairy course is conducted for six weeks, commencing in the middle of February. It is designed to fit men for the management of the private dairy. Sixty-eight lectures are given on dairying, dairy chemistry, crops, dairy breeds of cattle, their care, selection, and feeding, and veterinary science. These lectures are supplemented by practical work in the dairy and barn.

Cost: Fee, $5; board and room per week, $4.50; two white suits, $2.

Buildings: Class-room work is conducted in a temporary agricultural building. The practical instruction is given in the college creamery, which is in operation throughout the year and in which instruction is offered to a few at any time. Forty students can be accommodated at one time.

Equipment: All the apparatus necessary for a creamery and farm dairy, also a pasteurizing outfit.

Other facilities: Herds representing three breeds are kept on the station and college farms and used for scoring and judging dairy cattle.

RHODE ISLAND.

Rhode Island College of Agriculture and Mechanic Arts, Kingston.

[John H. Washburn, Ph. D., president; Arthur H. Brigham, professor of agriculture.]

For full information concerning dairy instruction, address Prof. Arthur A. Brigham, Kingston, R. I.

No regular short dairy course is offered. Arrangements can be made previous to the winter term to attend during that term a course of lectures on dairying given twice a week to seniors in the agricultural course.

Cost: Tuition to Rhode Island students, free; board and room per week, $3.50.

Equipment: A dairy department has been projected and funds appropriated for purchase of dairy stock and apparatus.

SOUTH CAROLINA.

Clemson Agricultural College, Clemson College.

[E. B. Craighead, president; ——— ———, professor of agriculture.]

For full information concerning dairy instruction, address Prof. J. W. Hart, Clemson College, S. C.

A special course in dairying is not given, but instruction in practical dairy work is offered to any who apply. Butter or cheese is made daily throughout the year.

Cost: Fee, free; board and room per week, $4.

Equipment: A building especially constructed for dairy work is equipped with power and the necessary apparatus for testing milk and making butter and cheese according to the most approved methods. It can accommodate thirty students at one time.

Other facilities: A herd of eighty cattle, representing three pure breeds and their grades, furnishes the milk used in the dairy building.

SOUTH DAKOTA.

South Dakota Agricultural College, Brookings.

[John W. Heston, A. M., Ph. D., LL. D., president; E. A. Burnett, B. S., professor of agriculture; J. M. Trueman, B. S., assistant professor of dairying.]

For full information concerning dairy instruction, address Prof. J. M. Trueman, Brookings, S. Dak.

Dairy course: (*a*) A three months' course in creamery methods is offered in the winter term, beginning about the middle of November. It is designed to give full instructions in the principles and practice of creamery management. The lectures treat of the breeding and care of dairy animals, composition and testing of milk, theory of butter making, and dairy mechanics. Practical work consists of milk testing and other laboratory work and butter making three times per week.

(*b*) The course described above is repeated in the spring term

(*c*) A three months' course in cheese making is offered in the fall term, beginning the latter part of August. Instruction is given by lectures and daily practical work.

A certificate is given after satisfactory completion of the course and four months' practical work in a creamery or cheese factory.

Cost: Tuition, $1; board and room per week, $2.50; two white suits, $2.

(*d*) Farm dairying is given in the spring term to the regular students in agriculture and the young women in the course of domestic economy.

Equipment: A building is fully equipped with apparatus for testing milk and making butter and cheese in large and small quantities.

TENNESSEE.

State Agricultural and Mechanical College of the University of Tennessee, Knoxville.

[C. W. Dabney, jr., Ph. D., LL. D., president; C. F. Vanderford, professor of agriculture.]

For information concerning dairy instruction, address Prof. C. F. Vanderford, Knoxville, Tenn.

No regular short dairy course is offered. Instruction in dairying is given in the agricultural course, special attention being given to milk for immediate consumption.

Equipment: A herd representing three different breeds with selected grades.

TEXAS.

State Agricultural and Mechanical College of Texas, College Station.

[L. S. Ross, president; J. H. Connell, M. S., professor of agriculture.]

For information concerning dairy instruction, address Prof. J. H. Connell, College Station, Tex.

A regular short dairy course is not offered. Instruction in dairying is given, however, in the regular agricultural course. Special arrangements can be made to attend for a period of twelve weeks between September and March and receive instruction in butter and cheese making, handling milk, and breeding and feeding cattle. Butter is made on the dairy farm daily.

Cost: Tuition, free; board and room per week, $3.

Equipment: Milk testers and all the apparatus necessary for making butter and cheese in large and small quantities.

Other facilities: A large herd of cows and silos.

UTAH.

Agricultural College of Utah, Logan.

[J. M. Tanner, president; Paul Fischer, B. Agr., D. V. M., professor of agriculture; F. B. Linfield, B. S. A., professor of dairying and animal husbandry.]

For full information concerning dairy instruction, address Prof. Paul Fischer, Logan, Utah.

Dairy course: A ten weeks' course in agriculture and dairying commences early in January. Five exercises a week are given on the composition of milk and methods of testing it, butter and cheese making, and dairy cattle. Cheese is made once and butter twice each week.

Cost: Tuition, $2.50; board and room per week, $2.50.

Equipment: The dairy room is furnished with power and contains machinery for making butter and cheese in large and small amounts and testing milk.

VERMONT.

University of Vermont and State Agricultural College, Burlington.

[M. H. Buckham, D. D., president; J. L. Hills, B. S., professor of agricultural chemistry.]

For full information concerning dairy instruction, address Prof. J. L. Hills, Burlington, Vt.

Dairy course: A four weeks' course in creamery work is offered in January. Instruction is given in butter making and testing and pasteurizing of milk and cream. In the lecture course it is endeavored to cover briefly the entire field of dairying. The physical and chemical properties of milk receive special attention.

Certificates are granted upon the satisfactory completion of the term's work.

Cost: Tuition, free; board and room per week, $4; two white suits, $2.

Equipment: The dairy building is equipped as a creamery, and contains several styles of the different kinds of machinery employed in making butter, also milk-testing machines and pasteurizing apparatus. Accommodations are limited to fifty students.

Other facilities: Herd of forty cows, Jerseys and their grades and Ayrshires. Dynamometer and steam-consumption apparatus for testing power consumed by apparatus.

VIRGINIA.

Virginia Polytechnic Institute, Blacksburg.

[J. M. McBryde, Ph. D., LL. D., president; D. O. Nourse, B. S., professor of agriculture; Wm. D. Saunders, assistant professor of dairy husbandry.]

For full information concerning dairy instruction, address Prof. D. O. Nourse, Blacksburg, Va.

A special dairy course is not offered. Any desiring instruction in dairying for a short period will be permitted to join the class in the regular agricultural course in February. The work continues about three months.

Cost: Tuition, State students, free; board and room per month, $9.

Equipment: A creamery and cheese factory has recently been erected and fitted with all the apparatus necessary for making butter and cheese. It will be run throughout the year as a creamery on a commercial basis.

Other facilities: Four breeds of stock are represented in the herd.

Hampton Normal and Agricultural Institute, Hampton.

[H. B. Frissell, principal.]

For full information concerning dairy instruction, address C. L. Goodrich, Hampton, Va.

It is proposed to organize a systematic course in dairying next year.

Work in the dairy is performed by the students.

Cost: Tuition, free; board and room per week, $2.50.

Equipment: A gravity creamer, separator, apparatus for making butter and testing milk.

Other facilities: A herd of cows supplies the milk used at the school.

WASHINGTON.

Washington Agricultural College and School of Science, Pullman.

[E. A. Bryan, M. A., president; William J Spillman M. S. professor of agriculture; Adolph Schoenmann, instructor in dairying.]

For full information concerning dairy instruction, address President E. A. Bryan, Pullman, Wash.

Dairy course: An eight weeks' dairy course begins about the middle of February. Two or three lectures are given daily; they treat of the care of dairy cows, practical dairy operations, management of factories, and dairy mechanics. About four hours a day is given to practical work, butter making receiving special attention the first four weeks and cheese making the remaining four weeks. It is recommended that students have some practical experience in dairy work before entering the school.

Cost: Tuition, free; board and room per week, $3.

Equipment: A creamery and cheese factory building is fully equipped with modern machinery and power necessary for making butter and cheese and for testing milk.

Other facilities: A herd of cows on the college farm supplies part of the milk used at the school.

WEST VIRGINIA.

West Virginia University Morgantown.

[J. L. Goodknight, D. D., president; L. C Corbett, B. Agr., B. S., professor of agriculture.]

For full information concerning dairy instruction, address Prof. L. C. Corbett, Morgantown, W. Va.

Dairy course: A regular short dairy course is offered in connection with the agricultural course in the winter term of twelve weeks. Instruction is given on the management of dairy cattle, butter and cheese making, milk testing, and creamery building.

Cost: Tuition, free; board and room per week, $3; incidental fee, $2.50.

Equipment: Suitable apparatus for giving instruction as outlined.

WISCONSIN.

College of Agriculture of the University of Wisconsin, Madison.

[Charles K. Adams, LL. D., president; W. A. Henry, B. Agr., dean; E. H. Farrington, M. S., associate professor of dairy husbandry, in charge of dairy school.]

For information concerning dairy instruction, address Prof. E. H. Farrington, Madison, Wis.

Dairy courses: (*a*) A twelve weeks' course in creamery and cheese factory work commences early in December and covers instruction in practical butter and cheese making. The work begins each week day at 8 o'clock with a one hour's lecture on dairying or an allied subject, including the composition of milk and its products, dairy bacteriology, dairy bookkeeping, care of a boiler and engine, and other physical problems of the dairy, and the breeding, feeding, and diseases of the dairy cow. After the lecture the class is divided into three sections, assigned respectively to the laboratory, creamery, and the cheese factory, the assignments being changed every two days, so that each student receives instruction in each of the three divisions of work every week. The afternoon's work closes with one hour's instruction by lectures, discussions, and quizzes on the operations of the day and scoring of butter and cheese.

(*b*) A few weeks after the beginning of the work those students showing the most proficiency are placed in an advance section to carry on experimental factory operations.

(*c*) Pupils whose standings are entirely satisfactory are allowed to take the course in pasteurization of milk and cream, this instruction being given the last four weeks of the term.

Persons taking the dairy course must be at least 16 years of age, have a common school education, and have had at least four months' experience in a creamery or cheese factory before being admitted.

Examinations are held at intervals throughout the term. Certificates are given to students after they have satisfactorily completed the full course and worked at least two seasons of seven months each in a creamery or cheese factory, provided one of these seasons follows the dairy course and the candidate practically has charge of the factory in which he works, reports his work properly, and the condition of his factory is satisfactory to an inspector sent out by the university.

(*d*) Advanced dairy instruction is offered to those who have completed the regular course. It deals with matters beyond those of the regular course, and includes experimental work in butter and cheese making and bacteriology.

Cost: Fees, $11; deposit to cover breakage (returnable), $2; board and room per week, $4; two white suits, $3; additional fee required from non-residents of Wisconsin, $16.

(*e*) The university creamery, which is in operation throughout the year, will accept at any time a few pupils without previous training, to be known as "working factory pupils," from whom no fees are asked. These are expected to remain from three months to one year, and have opportunity to become familiar with all dairy operations.

(*f*) Instruction in farm dairying is given to students pursuing the short course in agriculture. Daily practice is given in the separation of cream by deep-setting apparatus and hand separators; also in all the processes of making, printing, and packing butter.

Building: Hiram Smith Hall is entirely devoted to dairy instruction, accommodating one hundred pupils in the regular dairy course and one hundred more in the farm dairy course. It contains an engine room, creamery, cheese-making room, curing rooms, pasteurizing room, laboratories, room for instruction in farm dairying reading and lecture rooms, and dressing rooms.

Equipment: The building is equipped with different forms of apparatus for making butter and cheese in large and small amounts; also for pasteurizing and testing milk.

WYOMING.

College of Agriculture of the University of Wyoming, Laramie.

[Frank P. Graves, Ph. D., president; B. C. Buffum, M. S., professor of agriculture.]

For full information concerning dairy instruction, address Prof. B. C. Buffum, Laramie, Wyo.

A regular short dairy course is not offered. The principles of stock raising are covered in a general way by lectures in the agricultural course. Instruction in milk testing, analysis of milk and butter, butter making, and feeding will be given at any time to any who apply for it.

Cost: Tuition, $2.50; board and room per week, $4.